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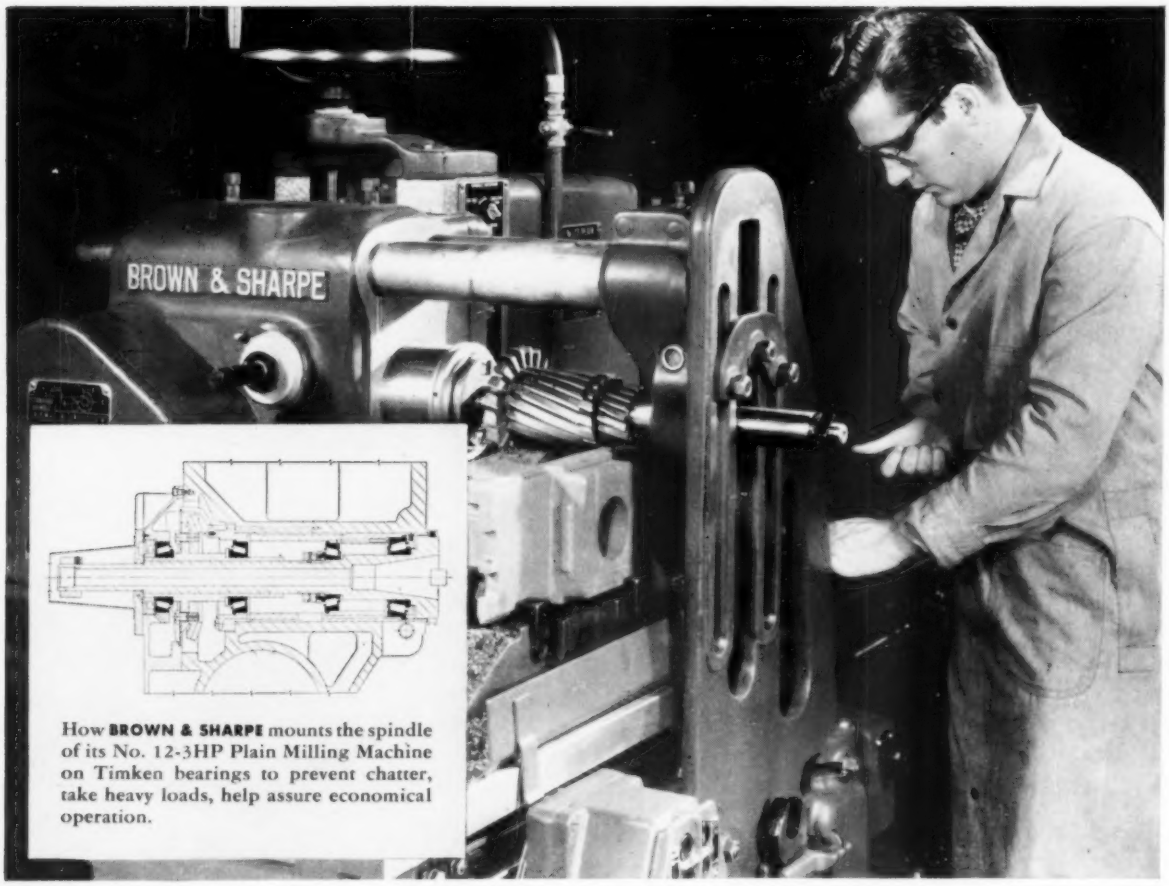
Lacrosse—Ready for Action

JULY-AUGUST 1957

(In two sections) Section II



How **BROWN & SHARPE** mounts the spindle of its No. 12-3HP Plain Milling Machine on Timken bearings to prevent chatter, take heavy loads, help assure economical operation.

Climb mills both ways . . . TIMKEN® bearings prevent chatter in heavy cutting

TO make heavy cuts without chatter, Brown & Sharpe mounts the spindle of its No. 12-3HP Plain Milling Machine on two Timken® tapered roller bearings. For smooth power transmission, they use four Timken bearings in the bevel gear drive to the spindle. And to take climb milling's pulsating loads, two Timken bearings are used in the feed screw drive. Result—production milling is fast and accurate. Here's why.

• SPINDLE RIGIDITY MAINTAINED

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This symbol on a product means its bearings are the best.

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ORDNANCE

LAND · SEA · AIR

The Magazine of Scientific and Industrial Preparedness Now in Its 37th Year

VOL. XLII | JULY-AUGUST 1957 | NO. 223

The Cover.—*Lacrosse, the Army's first field-artillery guided missile, is about twenty feet long and has four swept wings and four movable tail fins which control pitch, yaw, and roll. It has good range and accuracy and is air transportable.*

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ATLAS *Precisioneers*

"HUSH-HUSH" ASSEMBLIES FOR

THE FALCON

NO HIDING place "upstairs" for enemy bombers with The Falcon on the hunt. This newest guided missile is being produced for the U. S. Air Force by Hughes Aircraft Company.

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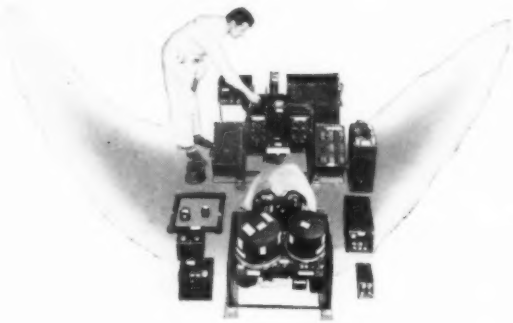

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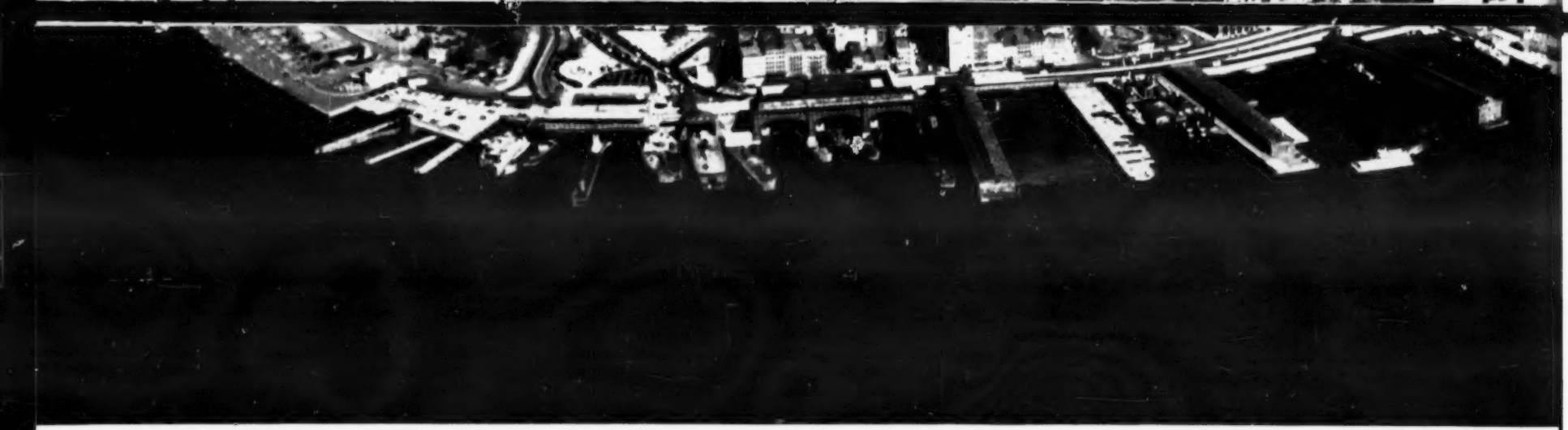

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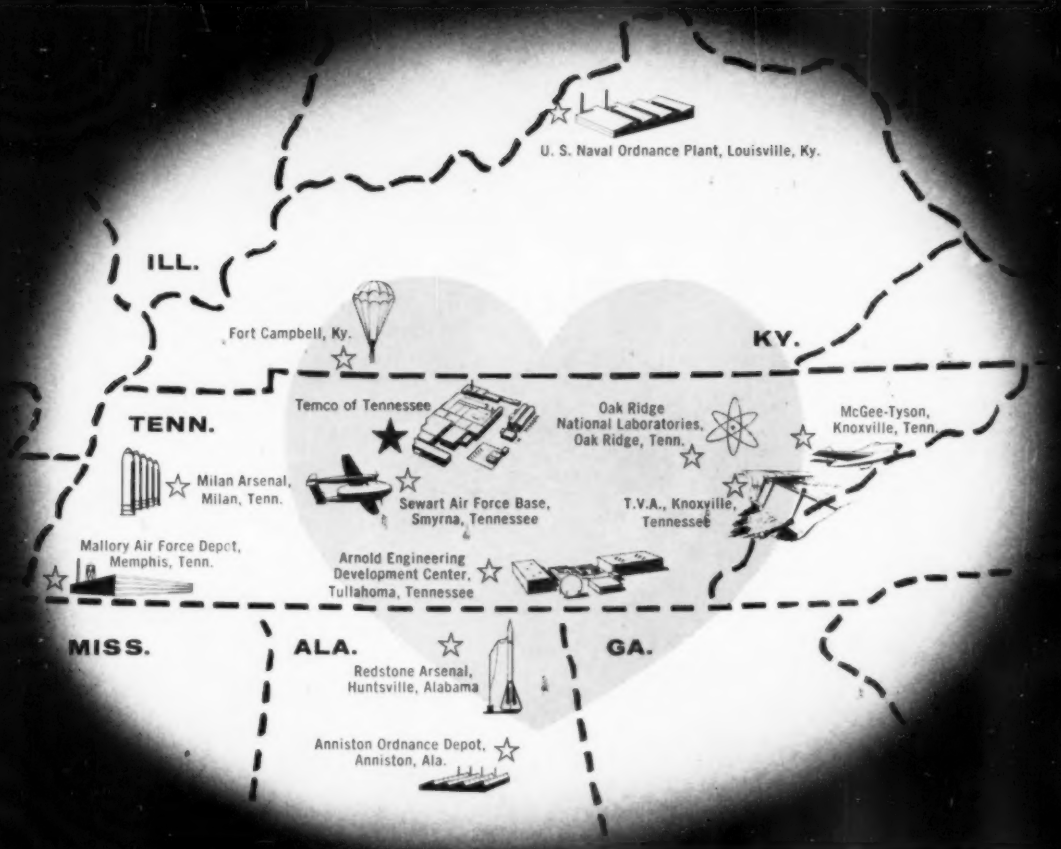

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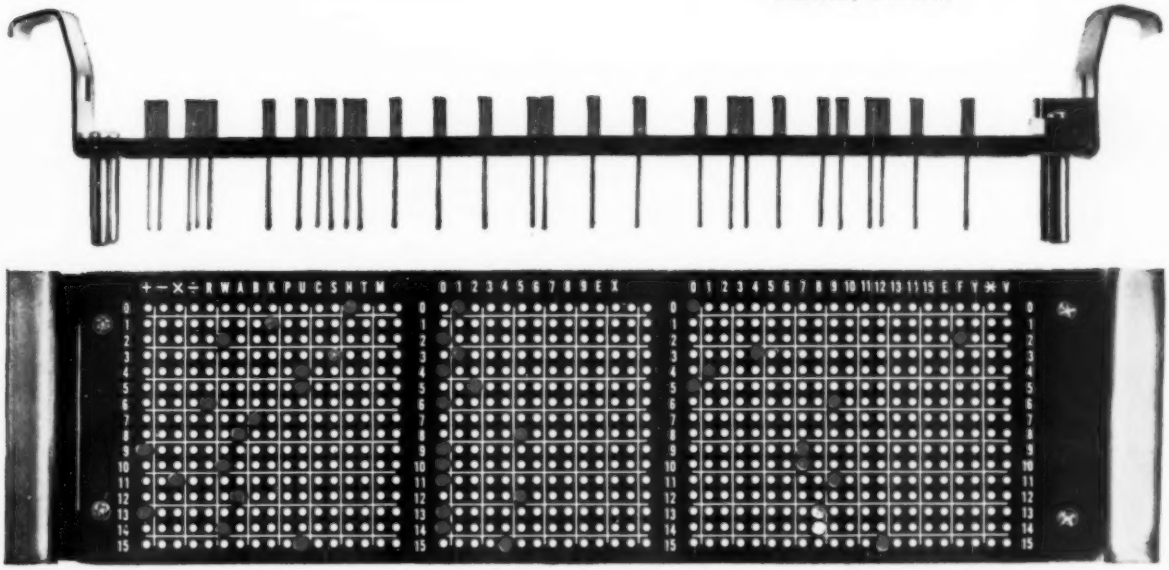

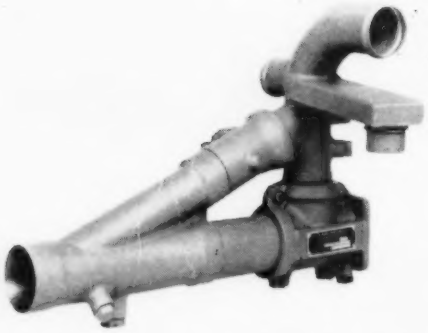

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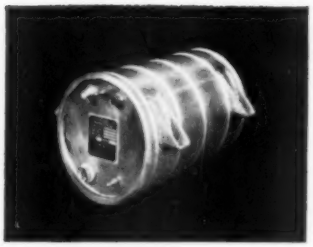
Engineering Beyond the Expected...



DESIGN beyond the expected
The DOVAP prototype (above) is one half the size called for in specifications.

PACKAGING beyond the expected
Shielding of critical areas and equalizing of heat enabled DOVAP to operate at higher temperatures than specified... without benefit of cooling by either conduction or convection.

PERFORMANCE beyond the expected
Where momentary loss of signal means the end of usefulness, DOVAP functioned unfailingly... under environmental conditions of shock and vibration more severe than specified.

ASSIGNMENT MISSILE

Withstanding torture is a specialty of Packard Bell's Doppler Velocity and Position indicator (DOVAP), designed and developed for an inter-continental missile (classified). In prototype environmental tests, this high powered Doppler Transponder was subjected to temperature, shock and vibration beyond the extremes expected in flight... beyond the extremes called for in specifications.

RESULT: Reliable signal and continuous transmission for an incredible life span.

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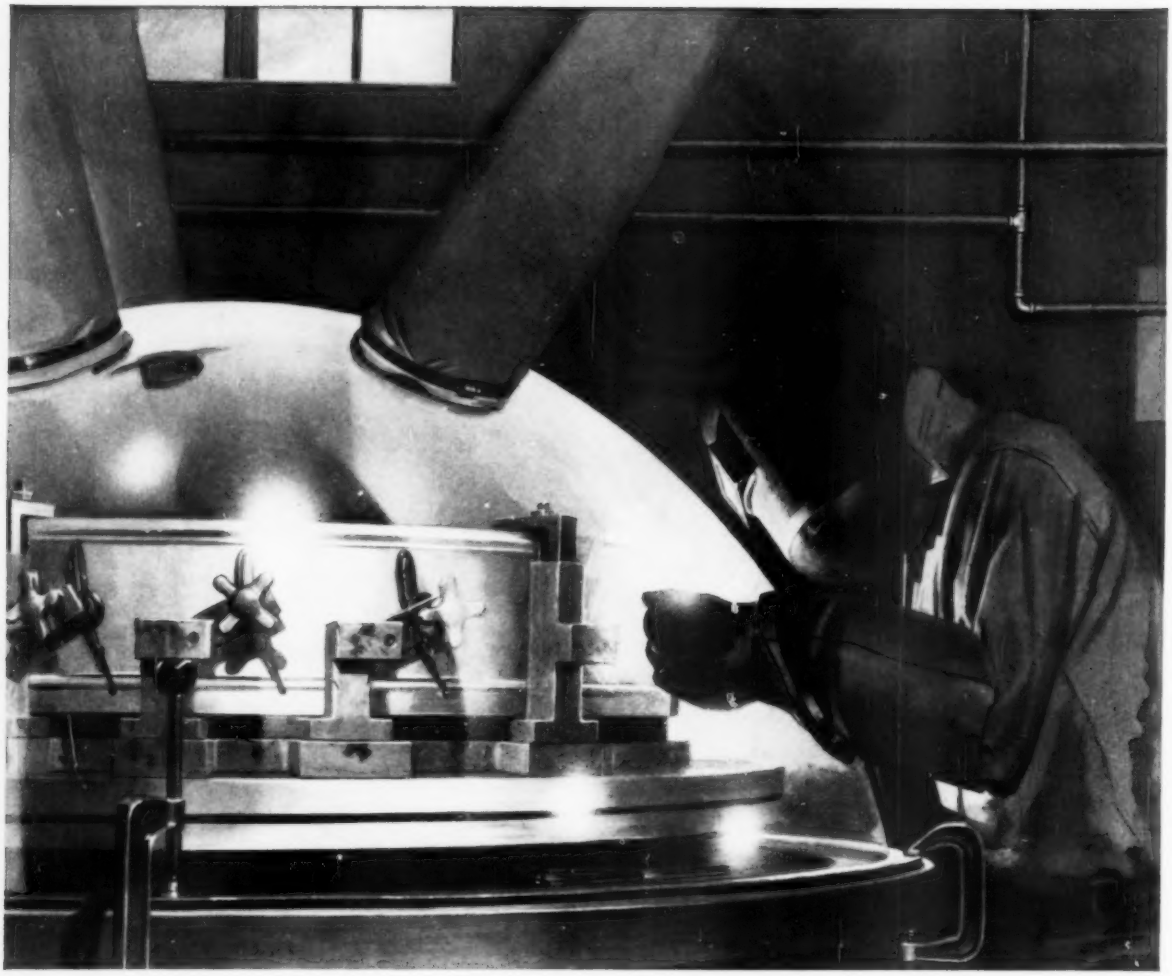

Solar Advanced Technology

Taming hard-to-work titanium with "purge chamber" welding

AIRCRAFT AND MISSILE DESIGNERS call for more and more titanium. The superior strength-to-weight ratio of this new metal saves vital pounds in airframe, engine and missile components. Solar is leading the way in taming this hard-to-work metal.

The plastic purge chamber, shown above, is a Solar development to facilitate welding of titanium in an atmosphere which protects the weld from elements in the air. It is one of many advanced fabricating techniques perfected in Solar laboratories to help realize titanium's promise. As a result, Solar today is among the largest users of titanium for aviation purposes, and is constantly testing and working with new materials requiring experience and expert ability.

This is one example of Solar advanced technology—a combination of skills, facilities and forward-looking pioneering. Perhaps Solar can bring a fresh viewpoint to your difficult metal-working problems. Write to Department D-36, Solar Aircraft Company, San Diego 12, California.

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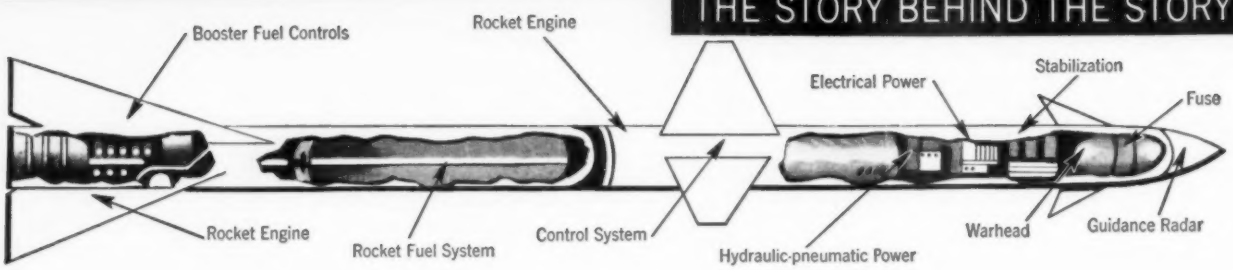
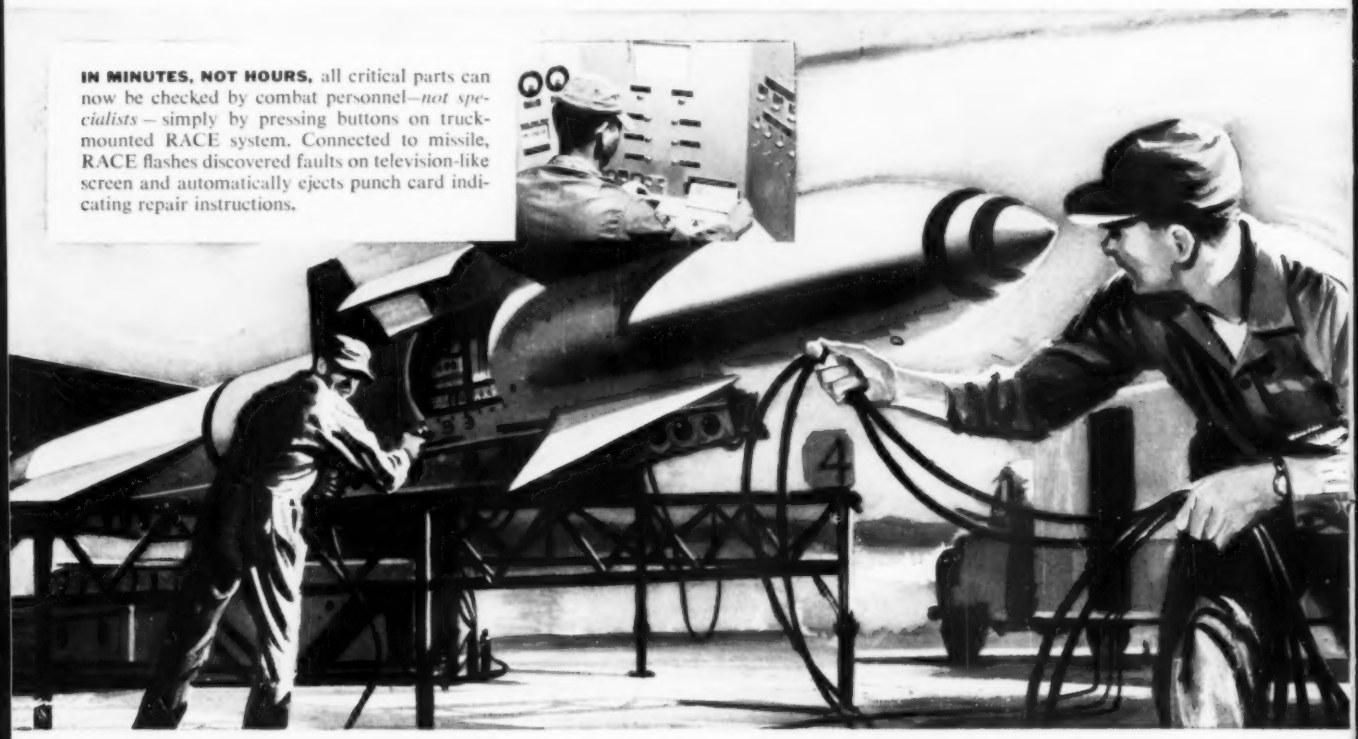
THE STORY BEHIND THE STORY



THOUSANDS OF "FAULTS" can develop in a guided missile, each capable of causing it to misfire or swerve off-course. Pre-launching check-out takes specialized technicians many hours. Under stress of enemy attack, a small but fatal defect might be missed.

IN MINUTES, NOT HOURS, all critical parts can now be checked by combat personnel—*not specialists*—simply by pressing buttons on truck-mounted RACE system. Connected to missile, RACE flashes discovered faults on television-like screen and automatically ejects punch card indicating repair instructions.



IN FLIGHT, RACE-checked guided missile flashes toward target, performing at the peak capacity engineered into it, with all components functioning to give missile best possible opportunity to reach and destroy objective.

"RACE" TO BOOST MISSILE STRIKING POWER

Electronic System Cuts Launching Time, Ups Dependability

When a rifle bullet misfires you simply fire another. Guided missiles, however, are costly and complex, packed with precision parts in hair-line adjustment. When these "birds" take off, they've got to fly right the first time!

At present, making sure missiles perform properly takes hours, even days, of careful testing by highly trained crews. And under the stress of actual combat, the best-trained crew might neglect an important check-point—and there are thousands of potential trouble-spots in a typical missile.

Sperry's new missile testing system called RACE does the job in only minutes—with little chance for error. RACE (for Rapid Automatic Check-out Equipment) tests all missile components at the launching platform, warns of the tiniest fault, even tells the operator how to fix it. And RACE doesn't make a mistake because it checks itself while it checks the missile. Result is, missiles are ready to launch far quicker and are more likely to perform with full effectiveness.

Designed to test supersonic aircraft as well as missiles, RACE will strengthen our national defense by keeping key weapons fit to fight.

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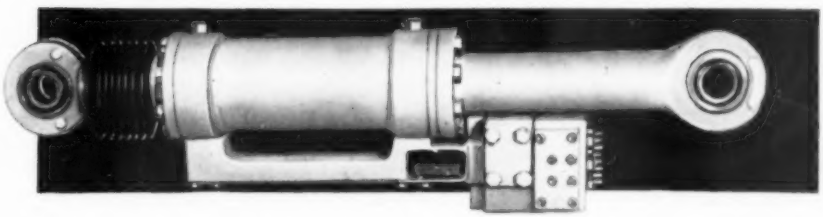

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Giant over-the-horizon antenna designed by Bell Telephone Laboratories for "White Alice," Air Force Alaskan defense communications network.

How UHF radio got seven-league boots

THE huge antenna systems which project ultra-high frequency radio communications beyond the horizon began when a Bell Telephone Laboratories engineer became intrigued with a strange phenomenon. Although these radio waves were supposed to be useful only over line-of-sight distances, the waves displayed a mysterious tendency to take off in a giant stride to antennas beyond the horizon.

This phenomenon had been studied both here and abroad, but no practical use was seen until the engineer became interested and thoroughly sifted the experimental data. He came up with the stimulating conclusion that over-the-horizon transmission is far stronger and much more dependable than was generally supposed. Further he predicted that it could be utilized to supply dependable broadband communications. He and his associates at Bell Laboratories confirmed the prediction experimentally, then drew up requirements for the first over-the-horizon UHF transmission system.

This pioneer work at Bell Telephone Laboratories has greatly increased the usefulness of UHF communications. For example, over-the-horizon transmission now provides critically important communications between remote military outposts in the Arctic and in the far north.

For the Bell System it can provide important new links for telephone conversations and television.

Kenneth Bullington, B.S.E.E., University of New Mexico; M.S., Massachusetts Institute of Technology; recipient of the 1956 Morris Liebmann Memorial Prize and the 1956 Stuart Ballantine Medal for his contributions in the field of over-the-horizon ultra-high frequency radio transmission.

Experimental antenna used in early over-the-horizon UHF radio transmission research. Research extended transmission from 30 miles line-of-sight to 200 miles.

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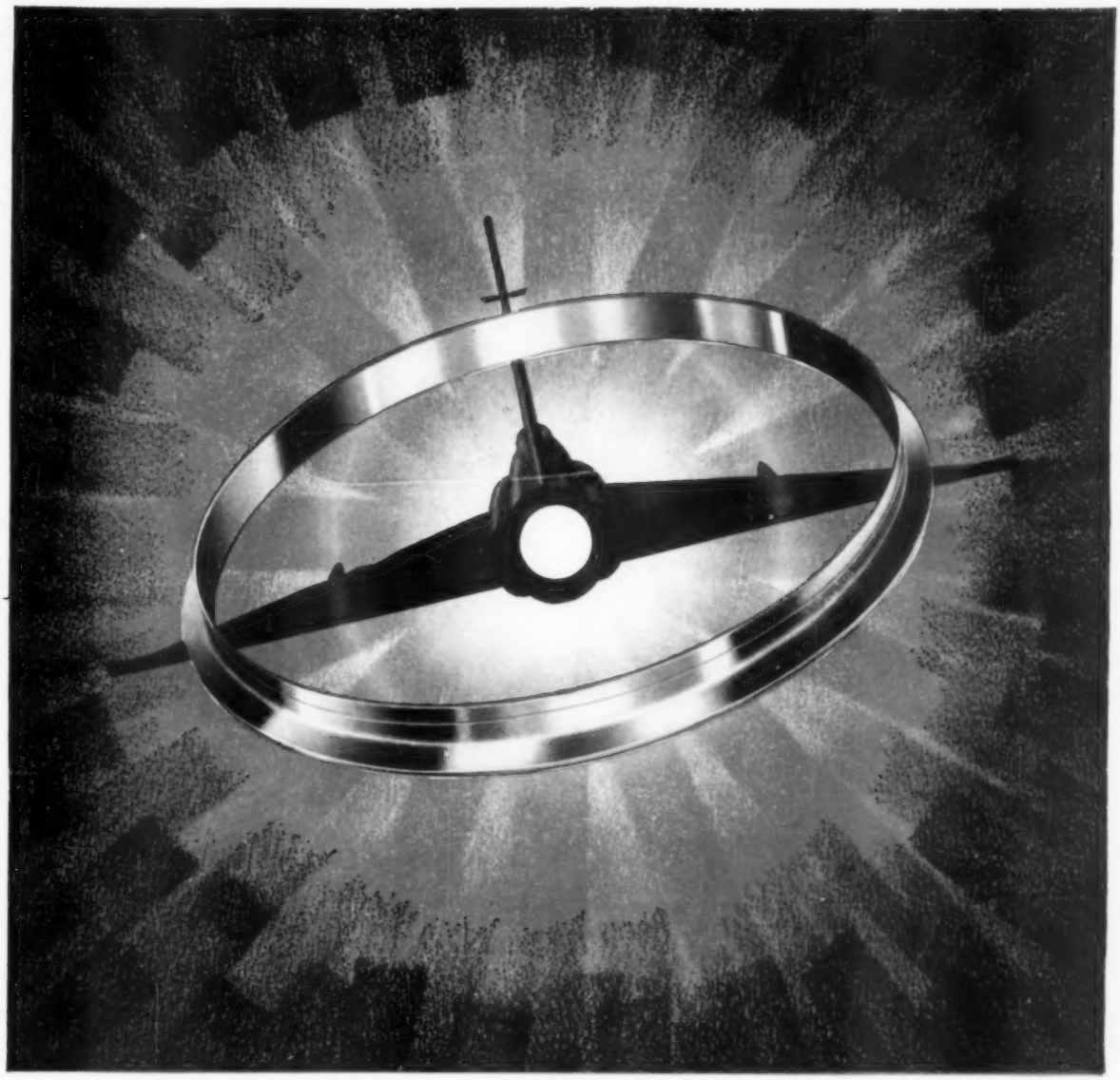

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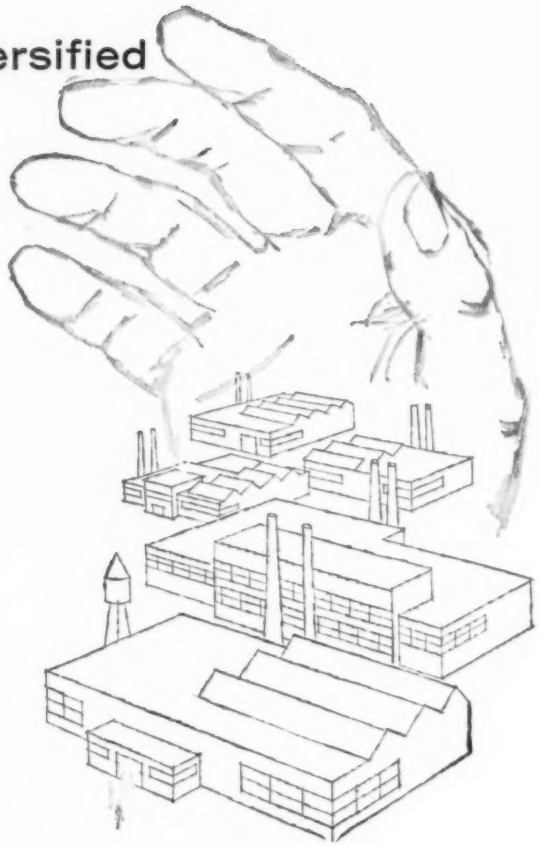

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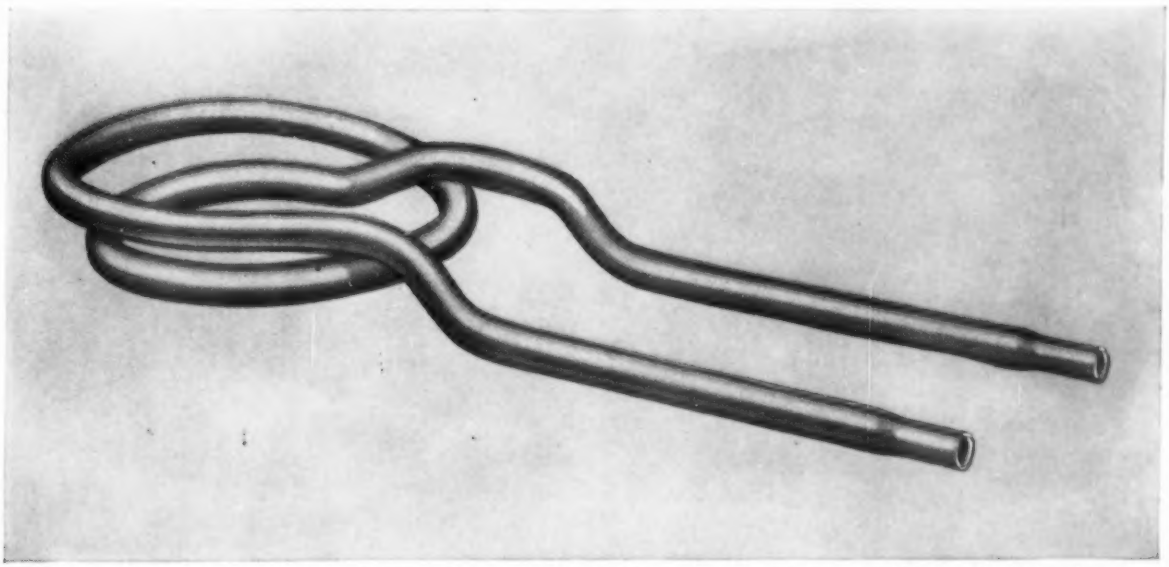


Complex shape of this oil-cooler tube lets it clear moving parts inside a compressor. Swaged ends are ready for brazing.

Bundy helps design a steel pretzel; bends it for Kelvinator compressor

Designing a compressor oil-cooler tube is tricky. It must bend like a pretzel to clear moving parts; stand up to punishing vibration indefinitely . . . yet be mass-produced quickly and economically. So when the problem arose, Kelvinator Division of American Motors Corp. consulted with the tubing experts—Bundy® design engineers.

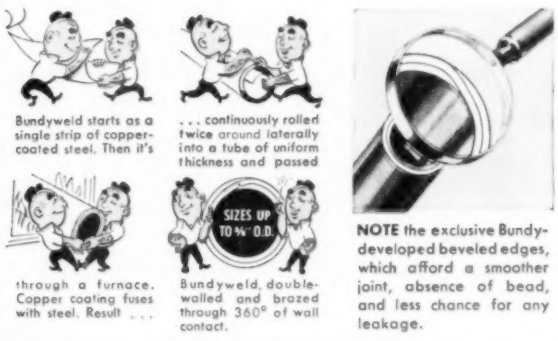
Working together, Kelvinator and Bundy designers carefully plotted the intricate bends needed for clearance within the compressor. Next, their design took form in Bundyweld® Tubing. Bundyweld is ductile enough for easy fabrication . . . strong enough to withstand vibration fatigue . . . yet costs less than the material used in previous designs. Finally, the job was turned over to Bundy's modern tubing-fabrication facilities for mass production.

This is but one of the countless problems solved by teamwork between Bundy and our customers in many industries. In addition to years of experience, we have the advantage of working with Bundyweld—the only small-diameter tubing made by the exclusive process shown below. *Leak-proof by test*, Bundyweld is the safety standard of the refrigeration and automotive industries . . . *is used on 95% of today's cars, in an average of 20 applications each.*

If you have tubing design or fabrication problems, Bundy has the answers. It will pay you to call, write, or wire us today!

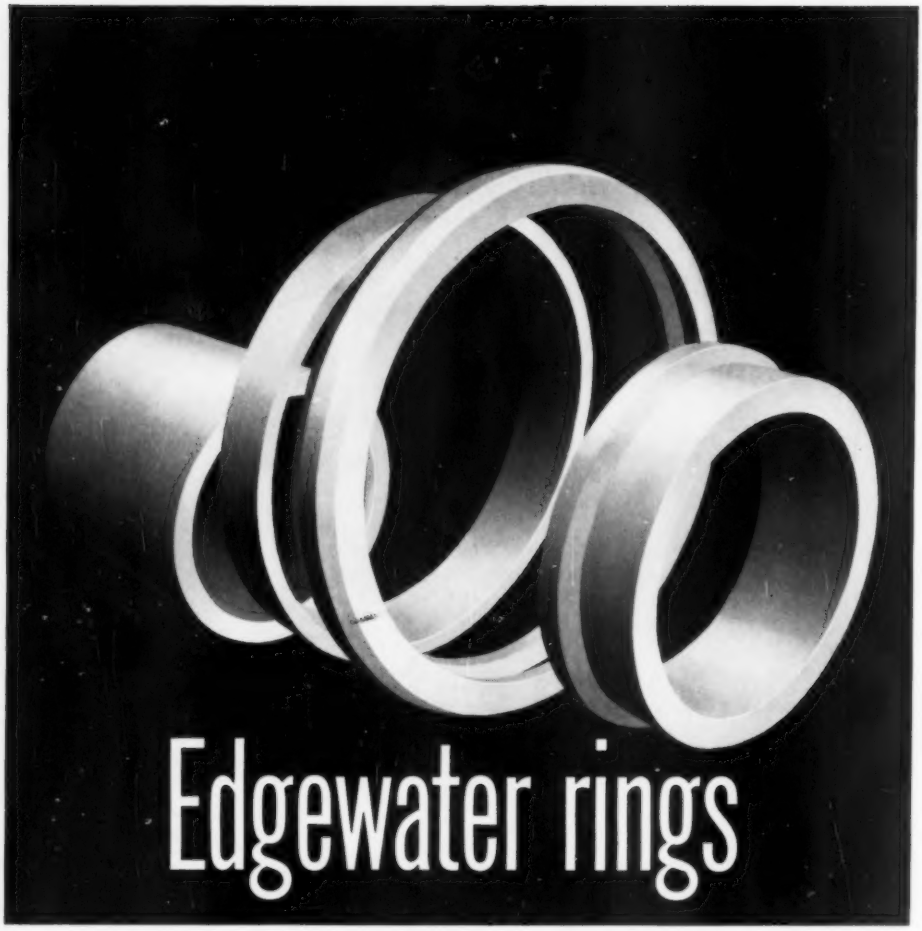
BUNDY TUBING COMPANY • DETROIT 14, MICHIGAN

WORLD'S LARGEST PRODUCER OF SMALL-DIAMETER TUBING. AFFILIATED PLANTS IN AUSTRALIA, ENGLAND, FRANCE, GERMANY, AND ITALY


Bundyweld starts as a single strip of copper-coated steel. Then it's
. . . continuously rolled twice around laterally into a tube of uniform thickness and passed
through a furnace. Copper coating fuses with steel. Result . . .
SIZES UP TO ⅝" O.D.
Bundyweld, double-walled and brazed through 360° of wall contact.
NOTE the exclusive Bundy-developed beveled edges, which afford a smoother joint, absence of bead, and less chance for any leakage.

BUNDYWELD® TUBING

DOUBLE-WALLED FROM A SINGLE STRIP



save critical materials . . . reduce costly machining . . . meet highest quality standards

for ordnance equipment

jet engines
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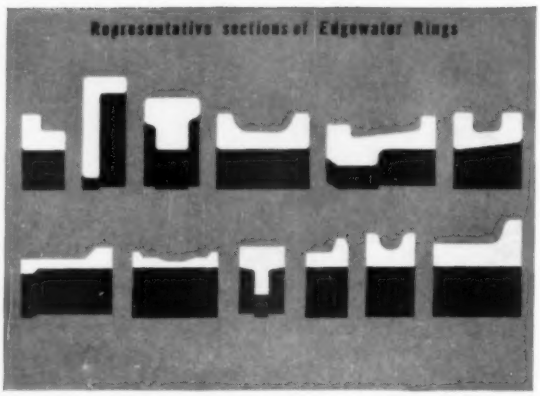
Your most critical specifications can be met by Edgewater Steel Rings—welded or weldless as required by the service. Formed accurately by modern methods, they are close to finish size as rolled. Weldless rings are rolled from solid steel blocks, in diameters from 5 to 145 inches. Welded rings up to 48 inches in diameter are formed from bars extruded or rolled to shape. Both types can be made in a great variety of sizes and cross-section shapes, as shown at the right. Being accurate in size and cross-section, Edgewater Rings save costly material and machining time.



Edgewater Steel Company

P. O. Box 478 • Pittsburgh 30, Penna.

AC BREAKS THE ACCURACY BARRIER WITH...

A giant T-square laid from here to any spot on earth couldn't plot a missile's flight with greater accuracy than AC's new inertial guidance system!

This is a new concept in inertial guidance—made possible by a new type of gyro stabilization of fantastic precision.

This virtually frictionless system provides the stable platform needed for pinpoint accuracy over thousands of miles of flight.

With the ACHIEVER, AC engineers' long experience in translating dreams into electronic circuits has contributed vital guidance to the top-priority Air Force ballistic missiles in America's arsenal of defense. AC electro-mechanical and production experience is ready and able—right now!

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THE ELECTRONICS DIVISION OF GENERAL MOTORS

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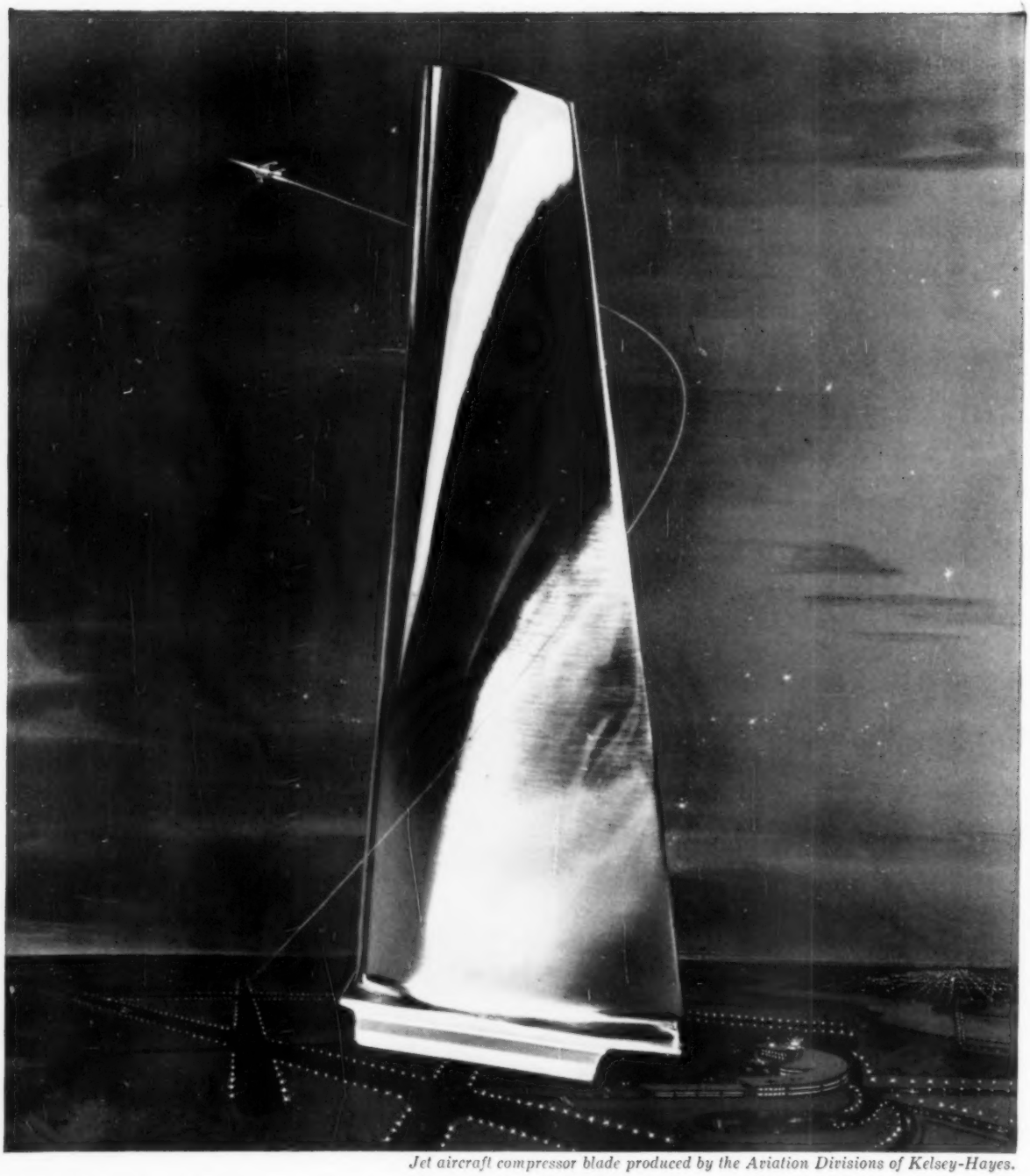

Jet aircraft compressor blade produced by the Aviation Divisions of Kelsey-Hayes.

precision blades for flight propulsion

Superalloy blades, buckets and vanes—*precision components for rotating and static assemblies*—are products of the Aviation Divisions of Kelsey-Hayes. Kelsey-Hayes also produces through its own vacuum melting facilities, the special alloy metals that go into these and other products demanding high tensile strength in the high temperature field. Kelsey-Hayes Company, General Offices: Detroit 32, Michigan.

KELSEY-HAYES

Aviation, Automotive and Agricultural Parts • Hand Tools for Industry and Home.

15 PLANTS / Detroit and Jackson, Michigan; McKeesport, Pennsylvania; Los Angeles, California; Windsor, Ontario, Canada Jackson, Michigan • Springfield, Ohio—2 plants—(SPECO Aviation Division) • Utica, New York—4 plants—(Utica Drop Forge and Tool Division) • Davenport, Iowa (French & Hecht Farm Implement and Wheel Division)

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From Great Lakes Steel come two durable, high-strength steels that let you design longer life, strength with lightness, and economy into your products. With their many diversified applications in modern metal design, it will pay you to investigate the outstanding advantages of these low-alloy, high-strength steels:

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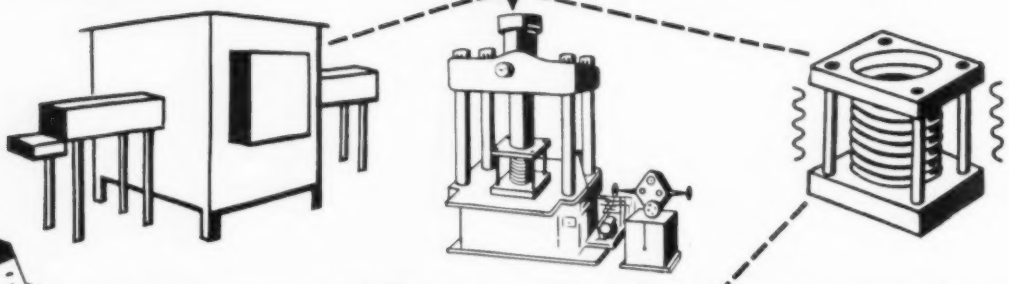
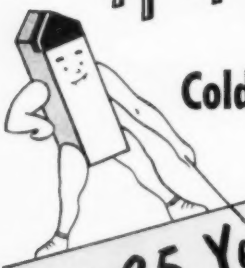




Cold Press and Sinter or Hot Press or Vacuum Sinter!

25 Years of Powder Metallurgy EXPERIENCE FOR SALE!

THE PROBLEM — Industry and Government are engaged today in a gigantic effort to develop new alloys and stronger metals. The future security of America depends on the success of this program. Powder metallurgy, possessing unique advantages not common with any other process, can solve many of the tough metallurgical problems created by the jet age.

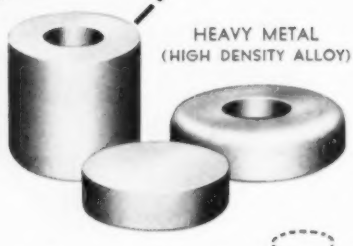
THE FACILITY — Metal Carbides, a pioneer in powder metallurgy, is well qualified by the experience of the past 25 years to help solve your particular problem. Our modern, well-equipped plants of over 100,000 sq. ft. are at your disposal, manned by skilled technicians and metallurgists capable of performing every technique known to powder metallurgy. Here are the facts:

THE PROCESS — Our equipment is varied and complete. Cold pressed and sintered parts can be processed in a vacuum or controlled atmosphere. Hot pressed parts can be produced up to 30" in diameter, up to 100" in length, and up to 5000 lbs. Other available processes include vacuum casting, centrifugal casting, hot forging and vacuum impregnation.

THE MATERIAL — Our experience covers the processing of carbides of tungsten, titanium, tantalum, molybdenum, chromium and columbium. Extensive experiments have also been conducted with various borides, silicides and oxides. Combinations of metals and ceramics have been developed which show great promise, and new possibilities seem unlimited.

THE ANSWER — Metal Carbides has found that by combining the best features of the above processes — with the right combination of metals and materials — totally new advantages result. Whether you require a structure that is porous, dense or tough — or a material that will withstand heat, corrosion or shock — let us put our experience to work helping you reach your objective! **Metal Carbides Corporation, Youngstown 7, Ohio.**

Send for new 84-page Catalog No. 55-G.



COMPRESSOR BLADES AND TURBINE BUCKETS FOR JET ENGINES

WIRE, WRITE or PHONE particulars of your problem or objective and we will advise promptly what our Powder Metallurgy technique can do for you.

METAL CARBIDES CORPORATION

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HOT PRESSED AND SINTERED CARBIDES · VACUUM METALS
HEAVY METAL · CERMETS · HIGH TEMPERATURE ALLOYS
OVER 25 YEARS' EXPERIENCE IN TUNGSTEN CARBIDE METALLURGY

FACTS

about

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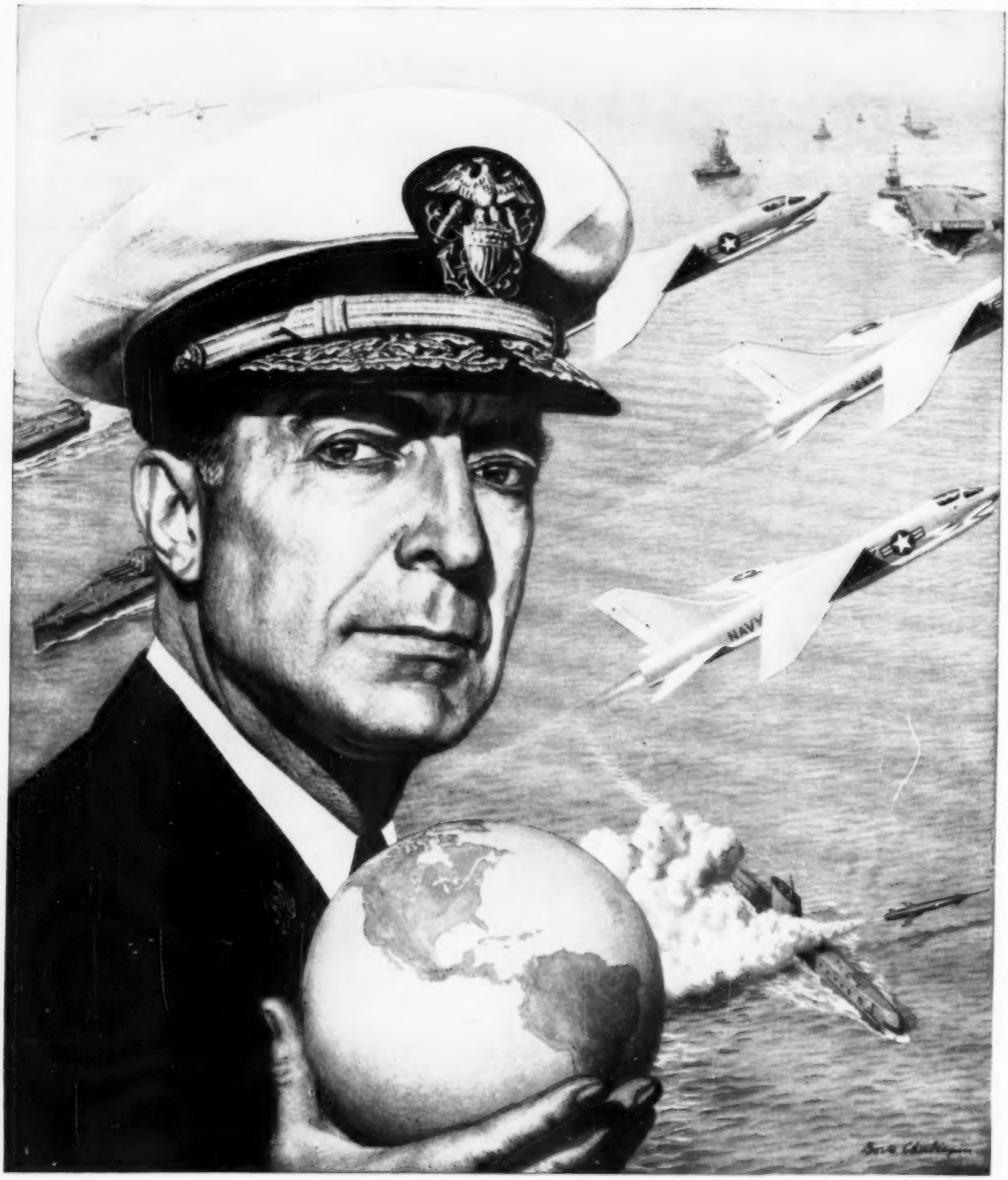
BALL BEARINGS MAKE GOOD PRODUCTS BETTER

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONN.



Today's Navy...power for peace

Your New Navy stands today as a nuclear-age bulwark of freedom, a powerful deterrent to aggression.

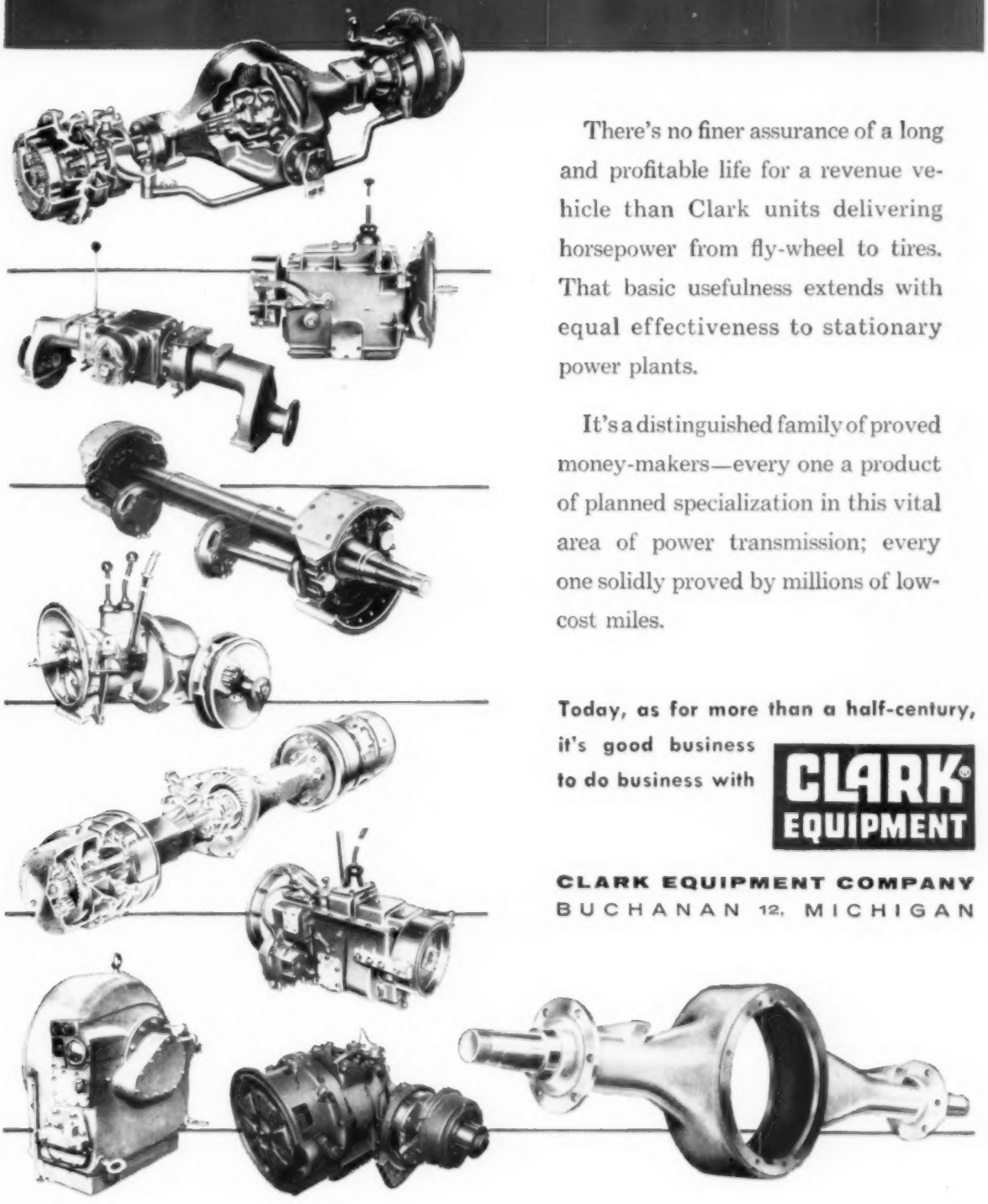
Leadership, manpower and mobility form the taut core of this strength. But to be an *effective force* the Navy must have *effective weapons.*

Chance Vought, with 40 years in the high performance military aircraft field, is dedicated to the complex science of developing and producing those vital weapons.

Record-breaking *Crusader* jet fighters, now in squadron status, and *Regulus* guided missiles, on station and ready for use when needed, represent a portion of Vought's growing contribution to Navy strength—a strength that means power for peace throughout the world.

CHANCE VOUGHT AIRCRAFT
INCORPORATED · DALLAS, TEXAS

From fly-wheel to drive-wheel
. . . let it be CLARK



There's no finer assurance of a long and profitable life for a revenue vehicle than Clark units delivering horsepower from fly-wheel to tires. That basic usefulness extends with equal effectiveness to stationary power plants.

It's a distinguished family of proved money-makers—every one a product of planned specialization in this vital area of power transmission; every one solidly proved by millions of low-cost miles.

Today, as for more than a half-century, it's good business to do business with

CLARK® EQUIPMENT

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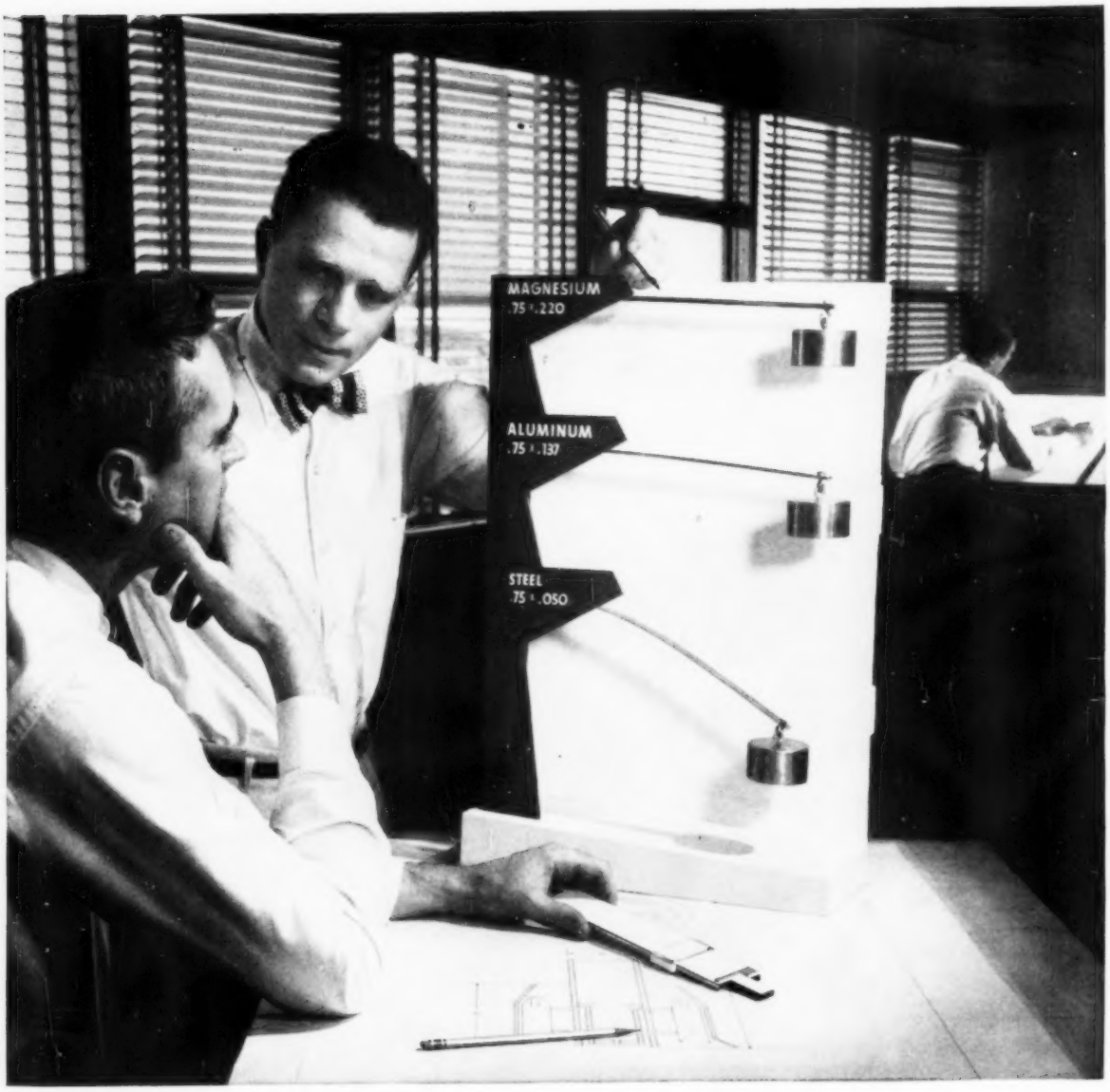


Rigidity! At equal weight, magnesium is 18 times stiffer than steel

Magnesium's unique combination of strength and light weight gives it some outstanding abilities as a structural metal. Take rigidity, for example. A magnesium bar has 22% the stiffness of a steel bar of the same dimensions.

But stiffness increases as the cube of section thickness. So, if thickness of the magnesium is increased to twice that of the steel, the magnesium bar will be over 70% more rigid—yet weigh only half as much. And if thickness is further increased until the bars are of equal weight, the magnesium bar will be 1878%—or over 18 times—more rigid!

Similarly, a magnesium bar of equal rigidity to an aluminum bar will weigh only 75% as much as the aluminum bar. At equal weight, the magnesium bar will be over twice as stiff.

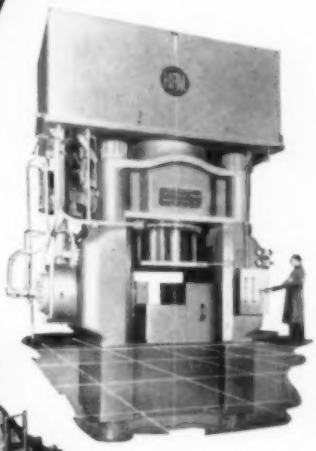
From these facts it's easy to see that magnesium can do a structural job equal to or better than steel and aluminum—and with appreciable savings in weight—whenever it's practical to increase section thickness. For more information contact the nearest Dow sales office or write to us. THE DOW CHEMICAL COMPANY, Midland, Michigan, Magnesium Department, MA 1402N.

YOU CAN DEPEND ON DOW

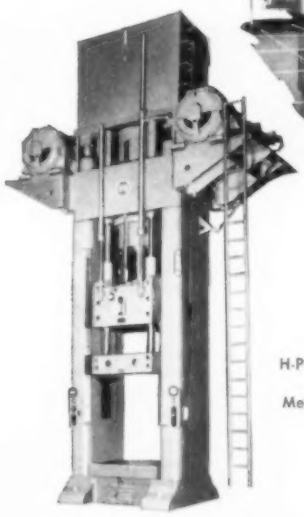
HPM

80 YEARS BUILDING A TRADITION

Unlike many anniversaries that are built to exaggerated proportions, H-P-M is entering its eighty-first year with a minimum of interest in the past. Instead our research and development have geared our efforts to a program for the future. We like to feel that throughout our long and varied experience we have learned to anticipate the needs of the many industries with which we work. It is their future that guides our planning and our policies for the days ahead. This thinking has traditionally guided H-P-M to its present position as a leader in the hydraulic industry. Our goals will be changed only to provide more and better service to the industries we serve.



H-P-M Metalworking Titanium Briquetting Press



H-P-M All-Hydraulic, Fastraverse Metalworking Press

HPM

THE HYDRAULIC PRESS MFG. CO.

Mount Gilead, Ohio, U.S.A.

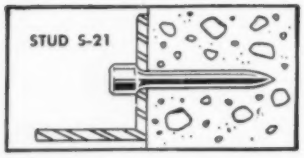
A DIVISION OF KOEHRING COMPANY

1877—1957

Just one of *101* Stud Driver uses!

No outside power source required—

Fasten angle iron to concrete or steel in seconds with the Remington Stud Driver



Recommended Stud for application pictured above—¼" Remington S-21 Stud with 22 caliber Power Load. Stud sets arrow-straight, iron is anchored permanently. Eliminates pre-drilling—no lost time.

Just a squeeze of the trigger anchors structural angle to concrete—without pre-drilling! This cartridge-powered fastening tool sets either ¼" or ⅜" diameter studs in steel or concrete . . . up to 6 per minute, either size. Over 40 Remington Studs to choose from, plus 22 and 32 caliber Power Loads scientifically graded to furnish *exact* power you need. Barrel change-over takes only 90 seconds *right on the job.* Take the tool anywhere, use it anywhere for light, medium or heavy-duty work. Most versatile fastening tool available!

SAVE TIME, CUT COSTS with this modern construction tool. Clip coupon for free booklet that shows how and where to use the Stud Driver.

Remington

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STUD DRIVER

Industrial Sales Division, Dept. U-7-8
Remington Arms Company, Inc.
Bridgeport 2, Conn.

Please send me your free booklet which shows how I can speed the job and save with the Stud Driver.

*Name*_____ *Position*_____

*Firm*_____

*Address*_____

*City*_____ *State*_____

ATOMIC ENERGY

NEW TYPE ATOM SMASHER

A new type atom smasher, a linear accelerator designed for the study of the elements and isotopes in the transuranic region, including an attempt to synthesize atoms heavier than element 101, has gone into operation at the University of California Radiation Laboratory. The machine is now accelerating nuclei of nitrogen atoms (nitrogen 14) to energies of 140 million electron volts.

The new instrument does not compete in energy with such ultrapowerful machines as the Radiation Laboratory's Bevatron, which accelerates protons, the nuclei of the lightest element, hydrogen, to 6.2 billion electron volts.

In contrast, the new atom smasher is designed especially to accelerate the nuclei, or ions, of very heavy atoms. It is therefore called a heavy ion linear accelerator, or "Hilac." The Hilac may permit the synthesis of elements heavier than Mendelevium (element 101), the heaviest now known. Elements heavier than uranium, element 92, are all synthetic and are obtained by transmuting uranium nuclei, step by step, into successively heavier atoms.

The instrument will permit a new type of exploration of nuclear forces. It will open up a new field of study of elements 84 to 90 and be used in studies of the effects on living cells of very heavy particles such as are encountered in cosmic radiation beyond the earth's atmosphere.

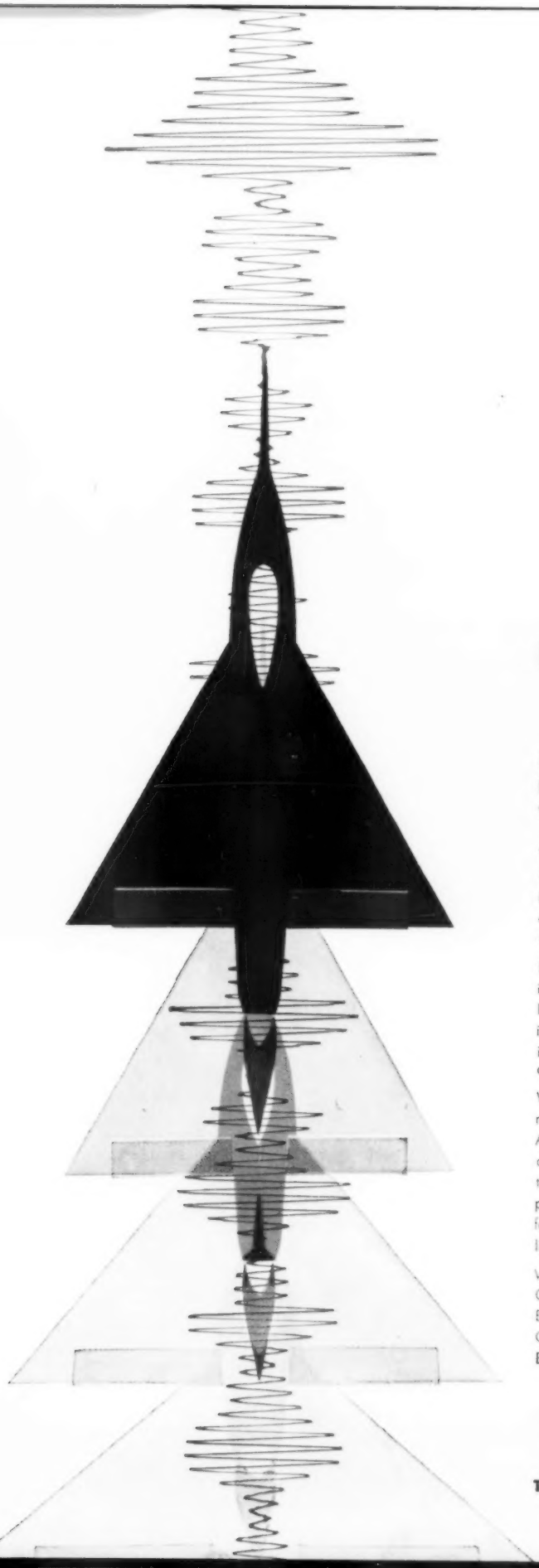
The machine represents, in part, a joint project between the University of California and Yale University. Yale and Berkeley scientists jointly developed the design of the machine, a duplicate of which is nearing completion now in New Haven.

NUCLEAR ENERGY COURSES

The Atomic Energy Commission will sponsor summer institutes in nuclear-energy technology for university faculty members at five Commission facilities.

Approximately 150 faculty members will attend the sessions at the Commission's Brookhaven, Argonne, and Oak Ridge National Laboratories, the Ames Laboratory, and the Hanford Plant. Each institute will be conducted by the staffs of Commission contractors for a period of two months.

Basic courses in nuclear-energy technology will be offered at the Brookhaven National Laboratory. The curricula will include reactor physics, chemistry and chemical engineering, reactor materials



KEEPING INSTRUMENTATION A STEP AHEAD OF SPEED

AVIONICS IN ACTION AT BURROUGHS: FROM RESEARCH AND DEVELOPMENT TO PRECISION MASS PRODUCTION

Today's dramatic new developments in aircraft performance demand equally dramatic new developments in flight *instrumentation*. And Burroughs is assuming ever greater responsibilities in this field through its work in the brand-new science of avionics.

Examples? Past experience in mass production of such instruments as altimeters, accelerometers and gyros. Plus, of course, extensive research and development in totally new concepts of flight instrumentation. And in all these enterprises, *reliability* consistently keynotes our performance.

We have, too, the capabilities and facilities for further research and development in this fast-moving field. And in all areas of our proved responsibility and competence—not only instrumentation but control systems, electronic computation, communications, data processing and others—we stand ready to see defense contracts *all the way* through. Yes, from preliminary research to installation and field service.

Write, call or wire Burroughs Corporation, Defense Contracts Organization, Detroit 32, Michigan. Or Burroughs Defense District Offices: Paoli, Pa. • Dayton, Ohio, 3898 Linden Ave. • Encino, Calif., 17071 Ventura Blvd. • Washington, D.C., 1739 "H" St. N.W.

BURROUGHS

THE FOREMOST NAME IN COMPUTATION

53,000 feet up ...on power by CAE
RYAN Q2 FIREBEE TARGET DRONE
J69-T-9 TURBO JET
J69-T-19A TURBO JET
MODEL 141 GAS TURBINE AIR COMPRESSOR
CAE power chalked up another record recently, when a Ryan XQ-2B Firebee jet target drone set unofficial world's records of 53,000 feet altitude and 104½ minutes of flight at Holloman Air Force Base.
The J69-T-19A is one of three gas turbines now in production at CAE. A second version, the J69-T-9, powers Cessna and Temco jet trainers for Air Force and Navy respectively, while the Model 141 air compressor is the heart of the TC-106 mobile starting unit for jet aircraft.
ENGINEERS!
There's a challenging future at CAE for qualified technicians. For full information, address: C. D. Morris, 1470 Algonquin Avenue, Detroit 15, Michigan.
CONTINENTAL AVIATION
CONTINENTAL AVIATION & ENGINEERING CORPORATION
12700 KERCHEVAL AVENUE, DETROIT 15, MICHIGAN
SUBSIDIARY OF CONTINENTAL MOTORS CORPORATION

Atomic Energy (Contd.)

and metallurgy, and reactor instrumentation and controls.

The courses offered at the other four Commission installations will be of a more advanced and specialized nature. Each will require advanced technical education comparable to that gained from participation in the institutes held last summer at the Brookhaven and Argonne National Laboratories, or the equivalent in work experience.

The Atomic Energy Commission will provide cost-of-living stipends up to $750 per faculty member, matching amounts provided by each participant's academic institution, and will defray travel expenses. These funds will be administered by the American Society for Engineering Education, Urbana, Ill., to which inquiries may be directed. No tuition will be charged.

ATOMIC EXPERIENCE

The Atomic Energy Commission has enlarged its program under which privately employed nuclear scientists and engineers may obtain specialized work experience in Commission laboratories and plants as an aid in the further development and use of atomic energy for peaceful purposes.

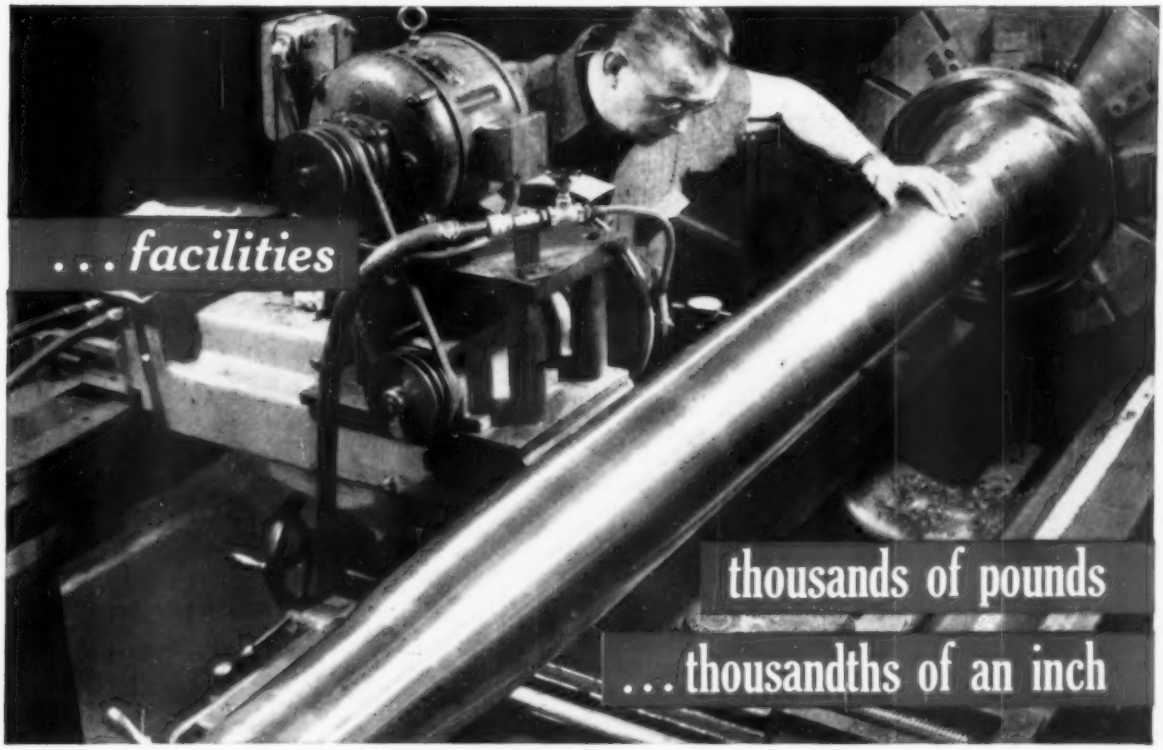
The program will be administered by Commission field offices, assisted by the Commission's Division of Civilian Application. Its primary purpose is to help people already generally educated and trained in nuclear science and technology to become familiar with specific uses; it is not intended as a program offering basic training.

The problem of a country-wide shortage of nuclear scientists is a separate, longer-range problem which the Commission is helping to relieve through schools and training courses conducted at its own facilities and through aid to the instructional programs of colleges and universities.

The work-experience program recognizes (1) that scientists and engineers qualified through training and experience to apply nuclear technology directly to specific projects are necessary to expansion of peaceful applications and to increased industrial participation and (2) that until a diversified private industry is developed the necessary training and experience often can be obtained only in Commission facilities.

Firms and organizations interested in the program should address their inquiries to the Commission's Field Operations Office having jurisdiction over the facility in which work experience is sought. Inquiry may be made, too, of the Director, Division of Civilian Application, Atomic Energy Commission, Washington, D. C.

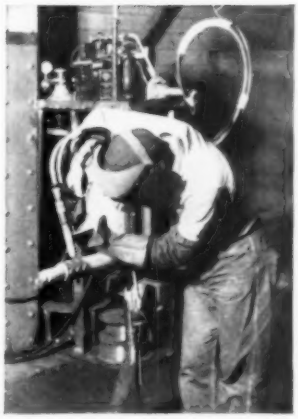
Applications will be considered on the basis of (1) whether the knowledge and training desired are available outside the



STEAM CATAPULTS FOR NAVY CARRIERS are made at Bliss' Canton plant. Shaft shown here is ground to special taper by mounting grinder on lathe post and guiding it with a specially built duplicating device.

20-mm MACHINE GUNS. Here, barrels are given a salt bath heat treatment in Bliss plant. In addition to production of 20-mm machine guns Bliss manufactures cartridge case and shell making machinery and other ordnance equipment.

140-TON FORGINGS. The 70-foot tie rods for the great hydraulic presses built under the Air Force Heavy Press Program filled little more than half the 120-foot bed of this huge engine lathe. It is one of the more-than-100 lathes in Bliss' 675,000 sq. ft. Canton, Ohio, plant.



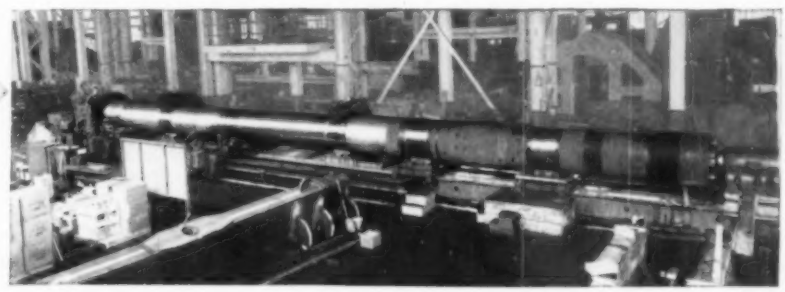
NUCLEAR REACTOR CONTROL RODS produced for the AEC by Bliss. Production requirements involve unusually precise machining and welding practices.

Virtually no contract machining or fabrication job is too large for Bliss facilities. And Bliss' record of long experience and successful performance on past contracts, both civilian and military, is your assurance of precision craftsmanship. In short, before you decide who's going to build it, it's wise to get a bid from Bliss.

BLISS
SINCE 1857

E. W. BLISS COMPANY
General Offices: Canton, Ohio
Presses, Rolling Mills, Special Machinery

Add these facilities to your own: 11 plants • 2,000,000 sq. ft. • An estimated $44,000,000 inventory of modern tools • Two Meehanite foundries, one iron and one steel foundry • Two fully equipped welding departments.



No shock is too much for the Lindsay Pressure Gauge ...proven in guided missiles!

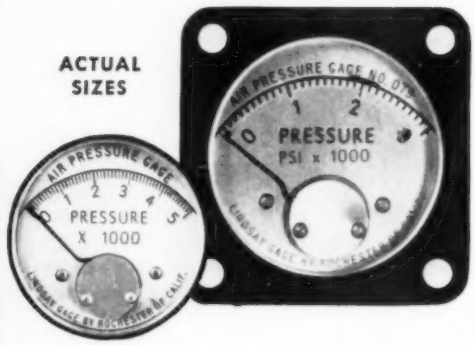
U.S. ARMY PHOTO

The RMC-Lindsay Pressure Gauge registers steady pressure readings from 500 to 10,000 PSI for extended periods. Not even the most extreme conditions of shock, vibration or temperature disturb its accuracy. It is the one high pressure gauge capable of meeting the tremendous demands of guided missile service, and is currently used in some of the nation's mightiest missiles and aircraft.

The RMC-Lindsay Gauge is a bourdon tube gauge which uses a multiple coil, helical bourdon tube with the pointer attached directly to the end of the coil. As compared to the traditional "C" spring bourdon gauge, the life of the Lindsay helical bourdon coil is more than 10 times greater and its proof pressure limits are increased by a factor of 3 or 4. Also, by using the multiple turn helical bourdon tube there are no linkages and pivots—this improves the gauge's shock resistance by a factor of 5 or 10.

The same basic gauge—with all its rugged, missile-service qualifications—is used for aircraft applications. Lindsay Pressure Gauges for aircraft are made for extensive cycling—will meet rigid endurance and over-pressure requirements. They are made in sizes down to 1" diameter.

ACTUAL SIZES



The helical bourdon element is, of course, not a new development. However, the RMC-Lindsay techniques in coiling, heat treatment, calibration and material specifications are new—and exclusive with RMC of California.

Whatever your high pressure gauge problems may be, why not let RMC engineering skill provide the answers. Write today, outlining your particular requirements.

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LINDSAY PRESSURE GAUGES

Commission's facilities; (2) whether the employees to be assigned appear to be qualified to take full advantage of the work experience and (3) whether the assignments can be arranged without undue burden on the regular work of the Commission facility.

NEW POWER REACTOR

The Power Reactor Development Company of Detroit, Mich., plans to build a sodium-cooled, fast-breeder reactor capable of producing sufficient heat to generate a minimum of 100,000 kilowatts of electricity. The Detroit Edison Company, principal member of the Power Reactor Development Company, will build the turbine generator and other nonnuclear portions of the plant and will distribute the electricity produced by the plant on its regular distribution system.

The company estimates that construction costs will total about $47,000,000 of which about $33,000,000 will be for the reactor and for equipment associated with the reactor portion of the plant. These costs will be borne by the company. The contract provides that the Atomic Energy Commission will provide up to $4,450,000 in assistance consisting of research and development work in Commission facilities, consultant and information services, assistance in training reactor plant operators and maintenance personnel.

PLUTONIUM PRICES

Prices to be paid by the AEC for plutonium produced in the operation of licensed power and research reactors in the United States until June 30, 1963, have been announced as follows:

For purchases until July 1, 1962, the price will range from $30 to $45 per gram depending on the plutonium 240 content of the material. For the year July 1, 1962–June 30, 1963, a single price of $30 per gram will be in effect. These prices supersede all previous guaranteed fair prices for this material.

The 1954 Atomic Energy Act authorized the Commission to guarantee prices domestically for a period not to exceed seven years. The prices announced today are based on these provisions. The Commission intends to continue the practice of extending annually, for one year, the period for which guaranteed prices of plutonium have been established so that the guaranty period will extend for a period of at least six years in advance at any one time.

In making such extensions, the Commission expects that the guaranteed fair price for plutonium will be reduced, as dictated by consideration of the value of the material for its intended use by the United States and giving such weight to the actual cost of producing it as the Commission finds to be equitable, to a level based upon the fuel value of plutonium in commercial power reactors.

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Missile Programs

Experience gained in producing over 100,000,000 forged parts, stainless steel weldments, and assemblies for all jet engine manufacturers is available now to designers and manufacturers of missiles.

Let us discuss your projects and your needs with you now. Your missile can then have the benefit of what the Jet Division has developed for the jet-engine industry . . . precision forgings, high-temperature alloys, resistance-welded stainless steel assemblies. Write or phone today to:

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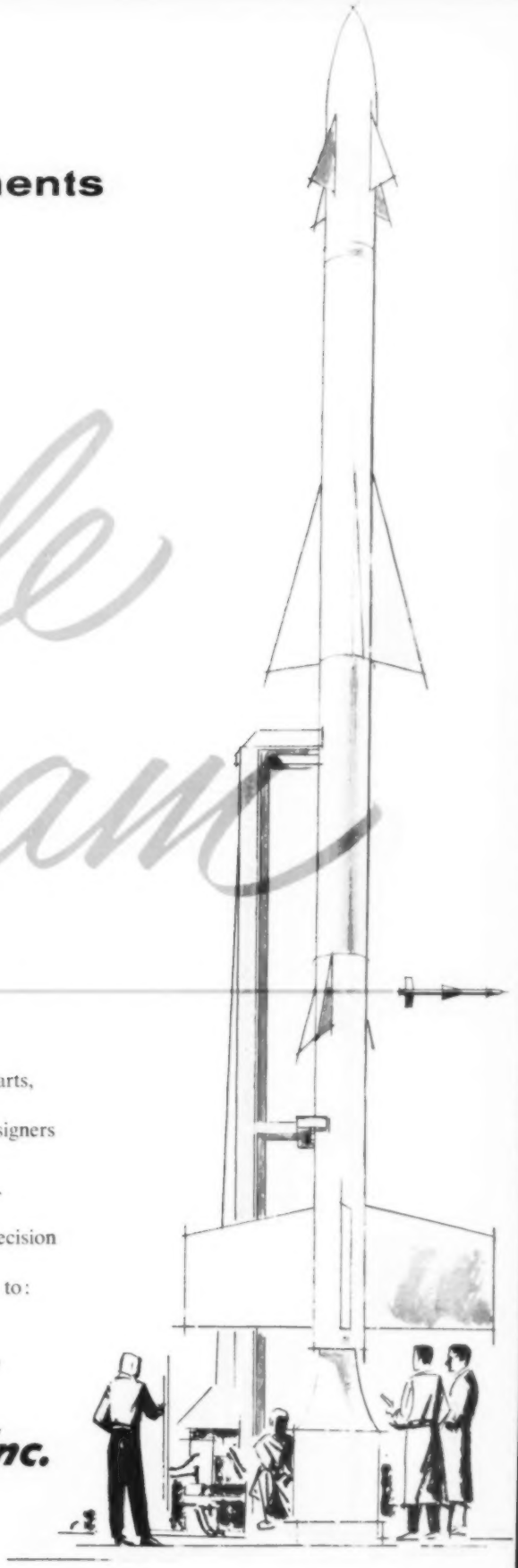
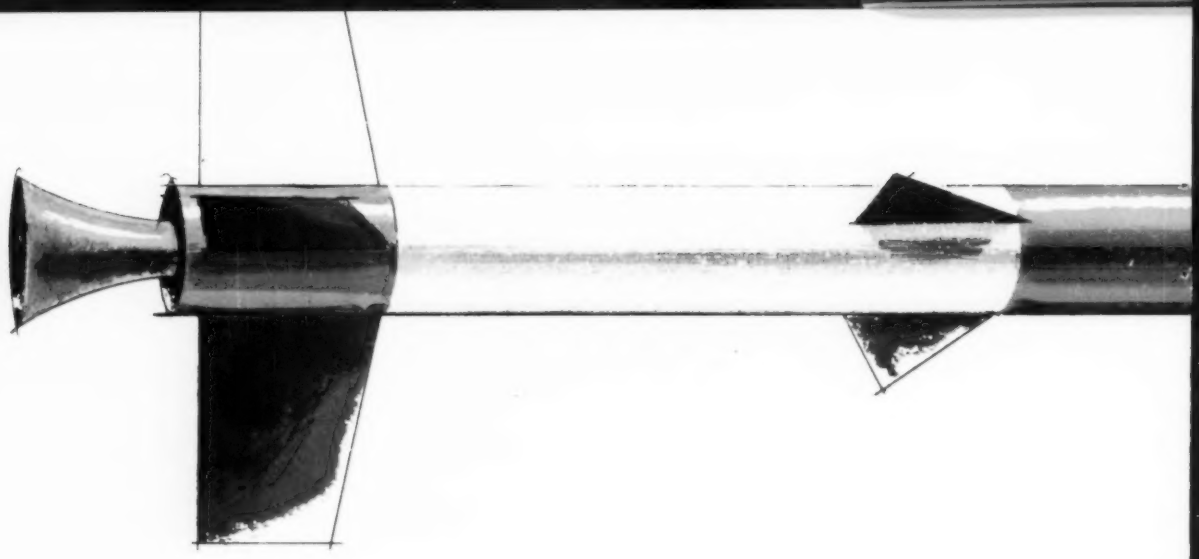




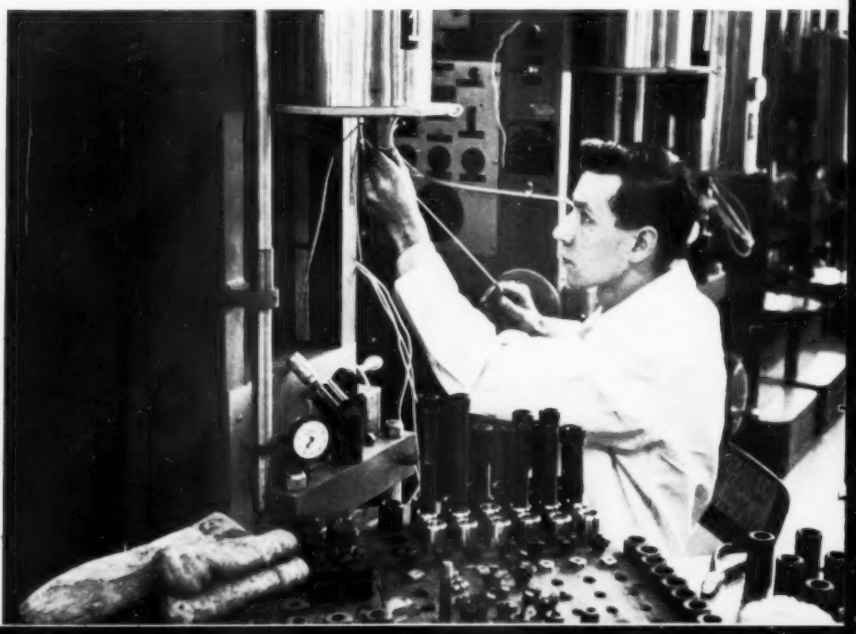
for your missile program...

complete engineering and test facilities to augment your manpower

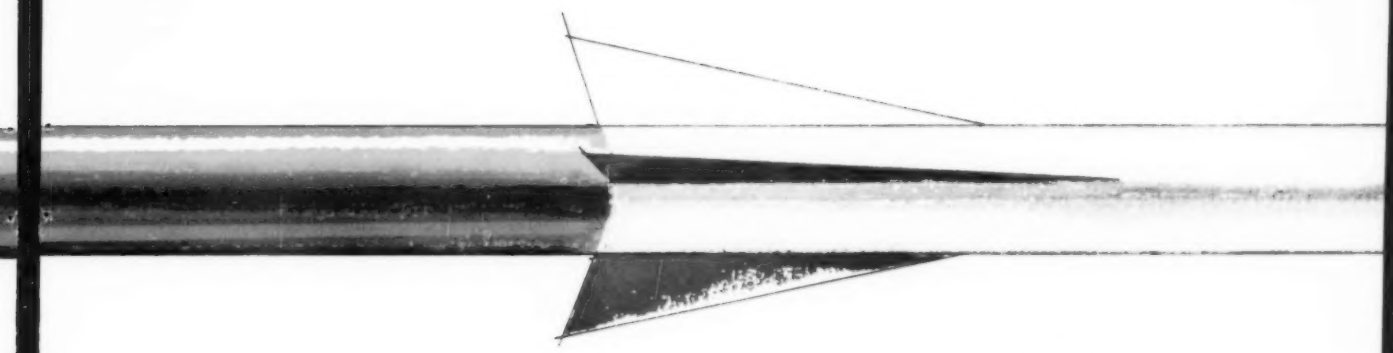
The men at the Jet Division who helped develop forgings and stainless steel weldments for jet engines are ready now to work with missile engineers on projects using their experience and talents.

You can use their services in the development of air-frames, tanks, and other structural components of missiles. You can also use their experience with metals at high temperatures in the design of your missile power-plants and skin-surface components.

A Jet Division engineer will be glad to call at your convenience to discuss your projects, timetables, and requirements.



Tensile tests at elevated temperatures are run on various alloys in Jet Division labs to determine their strengths under missile equivalent operating conditions.



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weldments in stainless and high-alloy steel and titanium made to your specifications

High-precision weldments that combine careful forming, all types of welding, and accurate placement of bosses and holes, can be designed and produced for your missile at the Jet Division.

Our experience in the production of titanium, high-alloy and stainless steel components for jet engines can give you a head start on your missile projects. Special Jet Division techniques of welding and stress-relieving provide maximum strength at minimum weight in metals that can resist the operating temperatures and stresses of missiles.

Let us discuss your weldment and machining requirements and show you how Jet Division engineering and production can quickly augment your own facilities.

MISSILE PROJECTS DEPARTMENT

JET DIVISION

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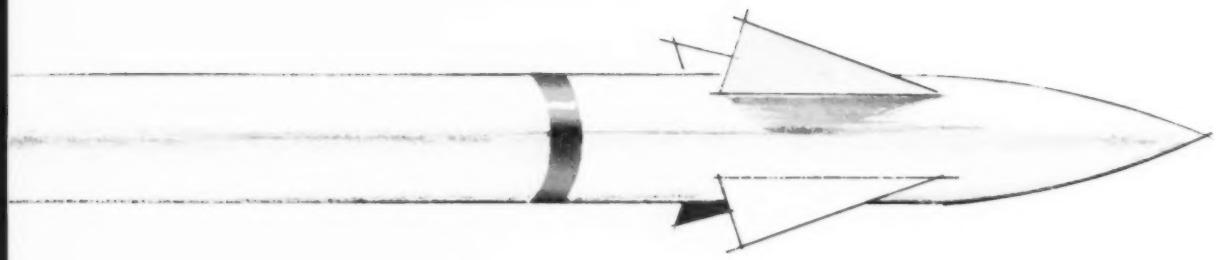
Special welding procedures and jigs are used in welding service-stressed stainless and alloy steel components into a finished structure at the Jet Division.



for your missile program . . .

Forgings made to closest tolerances for high-temperature service

Starting in 1944, the Jet Division was the first manufacturer of high-precision forgings for jet aircraft engines.

More forged parts of titanium, stainless and high-alloy steels for engines of every manufacturer have been made by the Jet Division than by any other producer.

Every jet engine manufacturer uses Jet Division forged parts.

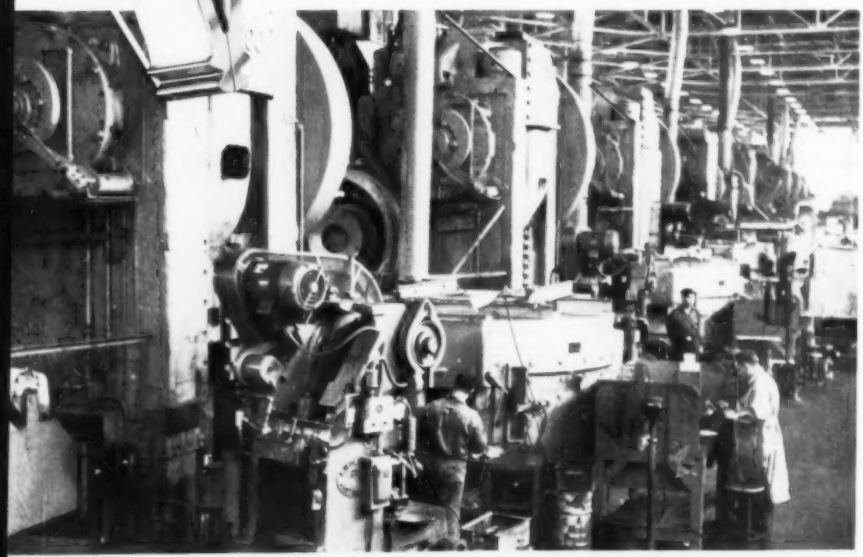
Forged to extremely close tolerances and contours, precision parts produced by the Jet Division often require no costly machining before assembly. Their use in your missile can speed delivery, reduce finishing time, eliminate capital plant investment.

Complete machining and test facilities are also available for your missile subcontract work.

Our sales engineers will gladly discuss your missile project requirements at your convenience.

WRITE FOR FREE BOOKLET

The complete engineering and manufacturing facilities of the Jet Division are described in Booklet MI-57. Write on your company letterhead for a copy.



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Battery of forging presses up to 4000-ton capacity produces precision parts in titanium, stainless, and alloy steels at the Jet Division's press-forging shop.

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HON. JAMES H. DOUGLAS

Secretary of the Air Force

Progress in Air Power

The Air Force looks to the future with new guns and guided missiles

James Henderson Douglas who was sworn in as Secretary of the Air Force on May 1, 1957, has a distinguished record of service in Government and in the Air Corps in World War II.

He had been serving as Under Secretary of the Air Force since March 3, 1953.

Born in Cedar Rapids, Iowa, Secretary Douglas graduated from Princeton University in 1920 and from the Harvard Law School in 1924. His college education was interrupted by active duty as a second lieutenant in the Army during World War I.

After admission to the Illinois bar in 1925 he practiced law and was in investment banking until 1932 when he served as Assistant Secretary of the U. S. Treasury. In 1934 he became a member of the law firm of Gardner, Carton and Douglas of Chicago, Ill.

Mr. Douglas served 3½ years during World War II in the Air Corps, becoming a colonel and chief of staff of the Air Transport Command. He was awarded the Distinguished Service Medal for his outstanding devotion to duty.

In 1946 Mr. Douglas returned to his law firm and prior to his appointment as Under Secretary of the Air Force he served as a director of the Metropolitan Life Insurance Company, American Airlines, Inc., Chicago Title & Trust Company, and the Chicago Corporation. He is also on the board of the University of Chicago, the Boy Scouts of America, and the Fund for the Advancement of Education and has served in many civic groups. He belongs to the American, Illinois, Chicago, and District of Columbia Bar Associations.

THE United States Air Force is beginning a fiscal year that, in spite of a slightly clipped budget, heralds a period of great expectations of both satisfying achievements and startling developments.

In fighter-interceptor aircraft, the F-102 evolved finally into a successful plane, and the rest of the supersonic Century series is now in various stages of development up to the F-105B Thunderchief fighter-bomber now under test.

In bombers, a new structural development gives the B-52 such improved performance that production is being slowed in order to procure a maximum number of the new model. The new supersonic B-58 bomber, the Hustler, designed entirely under the weapon-systems concept, is showing great promise.

In armament, radical machine-gun developments give a terrific increase in firepower—yet aircraft speeds have risen so fast that machine guns must be backed up with rockets and air-to-air missiles.

AIR-TO-AIR missiles appear to be out of the arena of mysterious and special weapons and, overshadowed by long-range supermissiles, are being recognized as another item of ordnance equipment essential in any supersonic air weapons system.

But it is in the field of the gigantic intermediate and intercontinental ballistic missiles that the Air Force is directing its major effort.

The growing impetus is evident in a breakdown of the Air Force budget where the requirements for ballistic missiles have increased relative to other missiles. In 1956, about one-third of a billion-dollar allotment for missiles went into ballistic missiles, while in fiscal 1958 one-half of two billion will go to the same work. Air Force spokesmen report that they are well ahead in their program, having reached the flight-test phase for the intermediate range (1,500-mile) missile.

Such is the progress that the time when missiles can replace manned aircraft appears to be approaching rapidly as scientific advances and engineering wizardry add to our technology. Talk is rampant on strategic missiles, reconnaissance missiles, defensive missiles, and even a missile to be carried by an ICBM to defend itself against anti-missile missiles. As missiles for such tasks become operational it will mean a gradual reshuffling of forces in the Strategic Air Command and the Air Defense Command.

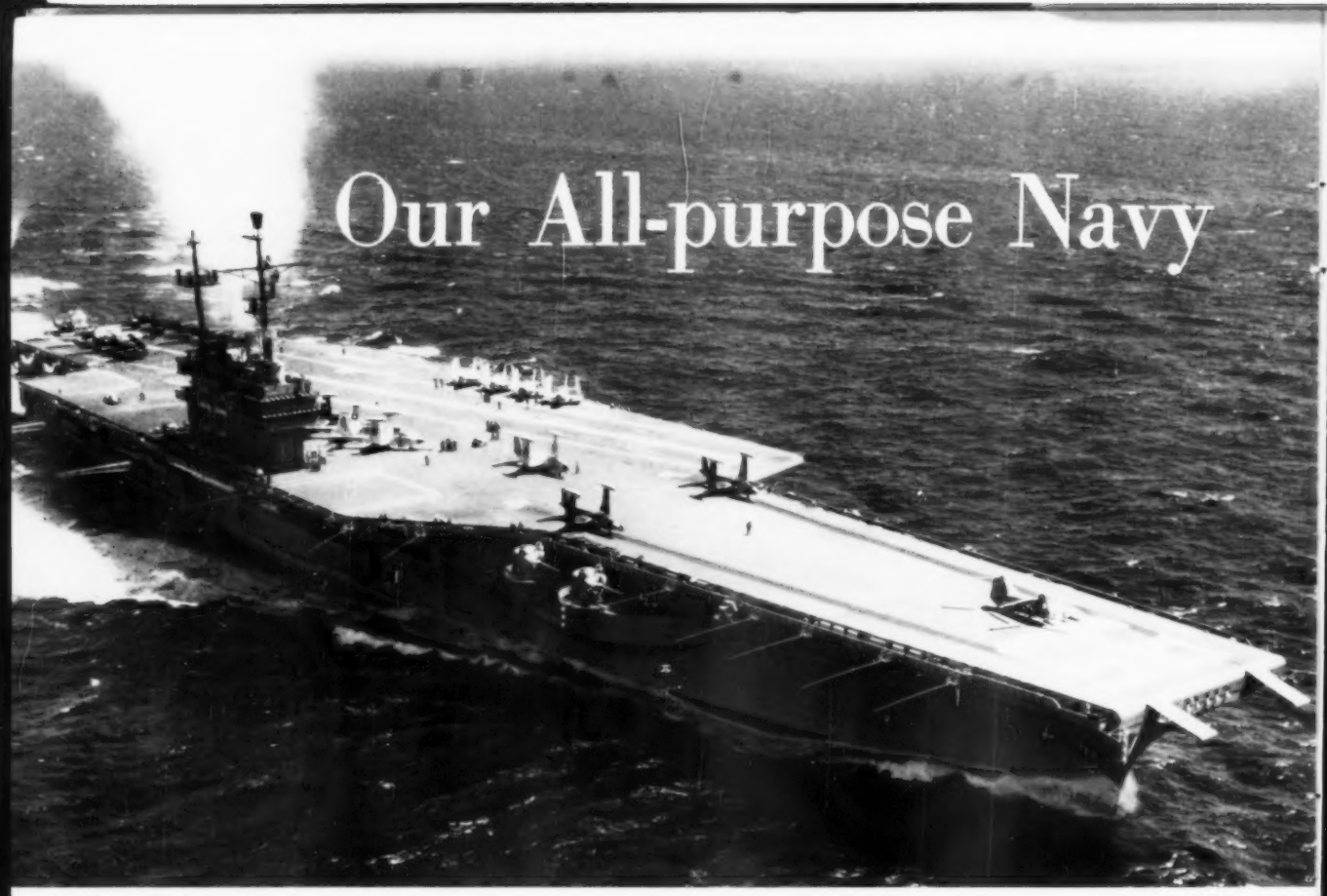
AS missiles take the place of piloted aircraft in many tasks, there will be fewer pilots needed for combat and more for expediting the movement of ground forces and their supplies. Trained technicians will be in demand as usual but for missile maintenance rather than the servicing of aircraft.

Instead of all thinking directed into aëronautical channels, many airmen will find themselves faced with all the ballistic problems of the old artillerist compounded to the third degree by complex guidance devices, vast trajectories, and the uncertainty of geographical locations. Of course, to solve the latter problem, our technologists will certainly have, when needed, a reconnaissance missile to determine accurate target locations and fly back to report them!

The Air Force is fortunate to have at its head a Secretary who brings continuity of experience when complex changes loom ahead. He is faced with the essential task of maintaining the vital pressure of our retaliatory Strategic Air Force during a long conversion period from aircraft to missiles.

In this endeavor the American Ordnance Association will support him fully, holding fast to its 38-year-old purpose of ensuring that industry will be prepared to meet the requirements of our armed forces for superior weapons.

Our All-purpose Navy



U. S. Navy

Versatile sea power gives our Government freedom of political action

Maj. George Fielding Eliot

BUILT-in versatility is the cornerstone of the U. S. Navy's concept of modern sea power. Coupled with worldwide mobility, versatility is the prerequisite of success in the application of sea power to the infinite variety of more-or-less limited problems incident to the cold war. It would surely be the key to victory at sea if unlimited hot war should unhappily confront us.

Versatility implies the possession of means to exert the exact kind and degree of power demanded by a given situation. Whether it be a formidable task force denying the Strait of Formosa to the massed power of Communist China or a couple of destroyers "showing the flag" in the Persian Gulf, the visible presence of the right kind of power at the right place and time exercises an influence on events which could not possibly be exerted by threats from afar.

Adm. Arleigh Burke, Chief of Naval Operations, told a Los Angeles audience recently:

"Naval forces . . . can land small squads of Marines if that is the kind of force the situation requires. They can employ atomic weapons if that is what is needed—or anything in between. The same forces do many things. The Navy is versatile. This versatility gives our Government the freedom of action it must have."

Versatility, however, is something more than a state of mind or a doctrine taught in war colleges. It must be implemented by the right kind of weapons and supporting "hardware" moving in an endless stream from concept to drawing board, from drawing board to test and development, from development to production, and from production to the fleet—so that today's fleet always will be prepared to meet today's needs with weapons in being, while the fleet of tomorrow will be able to meet the needs and dangers of tomorrow with weapons that are today anywhere between the blueprint and the proving ground.

Clearly, if hot war should come, the

Major Eliot is naval correspondent with General Features Syndicate and military analyst for the Mutual Broadcasting System.

ability of the Navy's fast carrier task forces to deliver, from a mobile base, nuclear weapons of ultimate power against land targets which may be as much as 1,500 miles away will be a mighty addition to the Nation's striking force. The existence of this ability, just as clearly, is a notable contribution to our deterrent power.

The deadly speed with which, during the Suez crisis, carrier task forces deployed in the far reaches of the Atlantic and Pacific Oceans, from which they could strike long before the enemy would have any hope of locating them, did not pass unnoticed in the Kremlin—of that we may be sure.

But in the deterrence or prevention of major war, now so vital a purpose of our military policy, the nuclear deterrent is not everything. There is also the day-to-day task of advancing the frontiers of freedom and of preventing the advance of Communist tyranny. In this task, nuclear weapons and their delivery systems may have only limited application, or no application at all—as in the Middle East at the present time.

IF there is one ailment which the Navy is determined to avoid above all others it is nuclear hypertrophy—which is to say, becoming musclebound (or brainbound) with nuclear weapons and concepts. To remain versatile, the Navy must remain ready to meet emergencies of any kind with the appropriate tools. The late Adm. Forrest Sherman, when he was ordered to the command of the Sixth Fleet, told this writer:

"I'm like a plumber who is sent to the suburbs on an emergency call without knowing exactly what the emergency is. I have to take with me all the tools I might possibly need; there may not be time to go back to the shop for the tool I didn't bring."

The planning and phasing of weapons programs to meet present and future needs of such variety is—as the readers of ORDNANCE hardly need be reminded—a task of infinite complexity. Practitioners of this art must combine the dexterity of a trapeze performer and the foresight of a minor prophet. They must, as one officer put it, "keep one foot firmly planted on the solid ground of the known present, while with the other they are water skiing merrily over the waves of the unknown future."

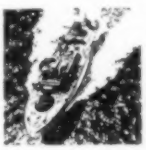
"To remain versatile, the Navy must remain ready to meet emergencies of any kind with the appropriate tools. . . . The planning and phasing of weapons programs to meet present and future needs of such variety is . . . a task of infinite complexity. Practitioners of this art must combine the dexterity of a trapeze performer and the foresight of a minor prophet."

Consider, for example, the gun and the guided missile. Today the Navy is producing no new models of guns for shipboard armament—probably the last gun that the Navy will ever turn out was the 3-in./70 antiaircraft weapon now being furnished to cruisers and some other types.

Only yesterday the gun was king of naval conflict. Today there are just eighteen really heavy guns afloat in U. S. ships in commission—the 16-inch rifles of the battleships WISCONSIN and IOWA.

Of course there are a good many 6-inch and 8-inch guns in cruisers, and a vast array of antiaircraft and double-purpose guns in ships of all sorts. But the guided missile is the wave of the future. Already it is afloat as an antiaircraft weapon and a-wing as an air-to-air weapon. Soon it will be the major surface-to-surface weapon of naval warfare, too.

Soon, however, doesn't mean now. The gun is still with us. Rear Adm. F. S. Withington, Chief of the Navy's Bureau of Ordnance, says that even if the current and prospective missile programs reach their fullest anticipated development in 1962, the Navy still will have in service about 90 per cent of its present number of gun barrels.



The need for keeping up active and reserve production capacity for ammunition and a duly balanced though diminishing stockpile for weapons which many Americans—including Congressmen—believed to be already as outmoded as the cutlass and the boarding pike of John Paul Jones' time, is not the least among the problems of Navy Ordnance.

The cold fact is, however, that the versatile Navy of today cannot depend on the guided missile alone. Against air attack the ideal defense now available involves a combination of guns, interceptor aircraft, and missiles—which, depending on circumstances, may well boil down to guns, period. True, guns will not reach the high-flying modern bomber or airplanes attacking with air-to-surface missiles. But we should not assume that every attack will be made with the enemy's optimum means or under conditions wholly favorable to him.

MOREOVER, the problems of shipboard supply and stowage of missiles have by no means been solved. Smaller missiles and more ample and versatile magazine facilities are coming along. But as of now, a ship wholly dependent on missiles for defense against air attack might find her defenses saturated by persistent sorties. If she had no guns she would have no defense at all, once the last missile was fired. The effect on morale alone might be disastrous.

For surface-to-surface fire, the gun is still high on the totem pole. It is conceivable that some missiles now available might be used for such purposes under special conditions, but to quote another naval officer, "if your problem is to halt a gun-running steamer that refuses to stop when challenged, a 5-inch shell is a damn' sight cheaper way of doing it than a missile."

As for missiles with nuclear warheads, they have no application at all in many of the present-day requirements of our versatile Navy. Gunfire support of landing forces, for instance, requires accurate attack on carefully selected targets. To take one recent example, the British and French at Port Said could not have used nuclear missiles without slaughtering tens of thousands of Egyptian civilians and bringing upon their governments the universal condemnation of mankind.

One illustration of the difficulties of this transition period is seen in the

The modern depth charge dropped in a pattern from the decks of a destroyer is a potent antisubmarine weapon (Defense Department photo).

guided-missile cruisers BOSTON and CANBERRA, recently recommissioned after a conversion which left them two 3-gun, 8-inch turrets forward, with launchers for Terrier surface-to-air missiles aft. The Navy stoutly defends this design as a necessity of the changing times, despite the traditional naval view that a hybrid ship possesses the defects of both "ancestors" and the good qualities of neither.

ROCKETS (unguided) as well as guns are included in the Navy's versatile armament. They are used for inshore fire support, as air-to-air weapons, and for antisubmarine purposes. New models in all these fields are coming into use. Here again, the decision maker must keep an eye on the wave of the future. Even the latest rocket-operated antisubmarine weapon must be improved if we are to capitalize on the greatly increased range of modern sonar and thus be able eventually to cope with the high speeds of nuclear-powered submarines.

No less than three models of new torpedoes are also directed primarily to antisubmarine needs. The contradictory requirements of less bulk and weight (for helicopter and aircraft use) and greater range, speed, and target-acquisition capability have to be reconciled and "packaged." Mines specially adapted to antisubmarine purposes, and possessing what might be called a high degree of sophistication in their detonating devices while eliminating weight to increase the payload of mine-laying aircraft, are in the works.

Incidentally it will be a happy day for our mine people when the Martin Seamaster gets into operational status. The jet seaplane promises to be the minelayer *par excellence*, once the bugs are out of the design. It might be observed that the principal value of the mine to the U. S. Navy is to keep enemy submarines confined to waters where they can do no harm.

Among minor ordnance items for the Navy may be included demolition materials, principally for use by underwater teams in the destruction of obstacles to clear the way for amphibious landing forces; also pyrotechnics and jato units.

Aircraft as well as ship armaments are constantly being improved. This is one field in which new machine guns are still being developed. The high speeds of modern aircraft demand the air-to-air missile (for example, the highly promising Sidewinder) or the rocket for air combat, but the machine-gun still has its value for ground strafing. Carrier-based aircraft may well be the only available source of air support, in particular situations, either for U. S. landing forces or for friendly ground forces—whether in all-out or limited warfare.

THUS it is quite easy to imagine circumstances in which our Turkish allies, engaged with pro-Communist forces, say in Syria, might desperately need air support which could be made available to them in time only from the decks of the carriers of the Sixth Fleet.

The development of the low-drag bomb, to reduce the air resistance and buffeting produced by older models, is too well known to require extended discussion here. A related problem, now in course of solution, is how to get rid of an internally carried weapon from an aircraft flying at supersonic speeds. Obviously there are many situations in which high-explosive, rather than nuclear bombs will be the appropriate weapon. Even the Lazy Dogs—solid slugs about the size of caliber .45 pistol bullets—may have value as antipersonnel aircraft weapons.

I trust that no missile enthusiast will consider that I am down-rating his pride and joy. Far from it. Indeed no service has done more than has the Navy in developing guided missiles of all categories. The Sidewinder is probably the most effective air-to-air missile now operational anywhere in the world; the Terrier is in service, with Talos hard on its heels; in the surface-to-surface field, Regulus II follows Regulus I for use from surface ships and submarines.

THE only point I am trying to make is that built-in versatility being a prerequisite for the adequate discharge of the Navy's varying missions, our naval

plumber must, as Admiral Sherman said, have all the tools in his box that he might need for any job that comes up today, before the improved tools that may be available to him at some future date are ready.

Gradually, of course, as the new replace the old, emphasis upon the older weapons systems and their ammunition supply is being reduced in the annual naval budgets. Mobilization reserve requirements are being reduced in some cases, with replacements well below anticipated expenditures.

All these adjustments represent carefully calculated risks—a tailoring of production needs for new operational hardware and for prototype hardware against the widening time gap between production step-up and dwindling stockpiles that would confront us if we had to fight a major war next week with what we have in hand.

The dollar sign continues to be a controlling factor, but it would be wide of the mark to say that it is the only controlling factor. There is room for sound military judgment to have its word.

Meanwhile, the Navy—widely deployed over the surface of the world's oceans and their connecting seas—continues to be the visible exponent of American power (and in many places the only such visible exponent) in the eyes of our friends as well as our enemies, and in the eyes of many anxious folk who do not think in such terms but only of their own immediate hopes and fears.

The swift, effective intervention of the Sixth Fleet in behalf of the independence of Jordan against Soviet-Egyptian attempts at subversion is only one example of the tasks the Navy is constantly being called on to perform. It represents mobile power, sea-based and sea-supplied, carrying its own logistic support along with it, ready to act effectively wherever there is water to float it, and with an inland reach that is constantly extending.

THERE is no other kind of fighting power in the world which can perform duties of this kind without the political complications attending the stationing of troops or the operation of air bases on foreign soil, from which the British have so recently suffered in Egypt and are suffering today on the island of Cyprus.

Perhaps most important of all, it is a type of power in which our Soviet opponents cannot match us, a type of power, indeed, which there is nothing in their experience that enables them to understand, much less to use effectively.

Versatility plus mobility are its twin characteristics. It can be there when it is needed and with whatever kind of force is needed. It can send a battalion of Marines ashore on liberty in the streets of Beirut, sounding an unmistakable, though nonlethal warning to ill-disposed elements in neighboring lands. Or it can, if need be, send aircraft carrying nuclear weapons from its floating bases into the heartland of an enemy nation.

Over 70 per cent of the earth's surface it can carry the weapons appropriate to these or any other missions it is charged with. And it can, in large measure, deny these advantages to any opponent.

As the years pass, weapons change—but the need of the American nation for versatile, mobile seapower will not change until the far-off happy morning when the dawn of lasting peace comes to this troubled planet.

Versatility demands the right weapons for the times. Thus with each passing year it becomes less likely that the 16-inch guns of our battleships will ever again be fired in anger at a hostile target. It becomes more likely that if the need for such attack arises, it will be met by a queer-shaped projectile with fire in its tail. The essential requirement remains: if the need ever does arise, the right weapon must be available to fill it.

The atomic submarines SEAWOLF (foreground) and NAUTILUS are valuable additions to the Navy's versatile weapons arsenal.

tion of the Army Reserve participate twenty years ago. Training in the whose members' civilian occupations

A Combat-Ready Reserve

The national defense might be best served if the National Guard were given the task of organizing and training large combat formations while the Army Reserve trained the technical and administrative units

William V. Kennedy

THIRTY-seven U. S. National Guard and Army Reserve divisions constitute the largest organized landpower reserve in the Western alliance. Upon the ability of those divisions to expand and fight depends the ability of the U. S. Army to meet "brush-fire" emergencies and the survival of the free world in total war.

The ten Infantry divisions of the Army Reserve are undermanned and underequipped. The six Armored and twenty-one Infantry divisions of the National Guard are somewhat better off, but still far short of the desired goal. Hundreds of units of both the Guard and the Army Reserve train in inadequate, poorly heated, and poorly lit armories. Both organizations are plagued by an excessive rate of personnel turnover.

The chaos into which the Middle East was plunged by the withdrawal of the British garrison from Suez demonstrates the continuing need for large bodies of troops as an indispensable adjunct to our mighty air and sea power. However, even large bodies of Regulars, at or near critical ground, have little meaning unless they are backed by powerful reserves ready to move to their support.

Since economics prohibit maintenance of the needed reserves as part of the Regular Army, we can conclude that there is a vital need for a large ready reserve force in civilian status.

Mr. Kennedy is former executive editor of the Pennsylvania Guardsman magazine and an officer of the 104th Cavalry Regiment, Pennsylvania National Guard.

The question that confronts us, then, is to what degree such a citizen force can be made truly "ready."

The National Guard and some units of the Army Reserve already possess a limited combat capability. The performance of National Guard troops during recent months in the face of mob violence and prison riots bespoke a high degree of discipline and unit cohesion.

By July 1, 1956, National Guard batteries had taken over seventy-nine antiaircraft artillery sites, operating them as an integral part of the Continental Air Defense system.

Lieut. Gen. Stanley R. Mickelson, Chief of the Army Antiaircraft Command, has announced that in the future the National Guard will man half of the Nation's Nike guided-missile sites—a vital factor in our air defense.

Army Reserve units have participated frequently with National Guard and Regular Army troops in disaster relief, performing many of the supply, command, and staff functions that would be required of them in war. Numerous technical units of the Army Reserve could assume their full wartime rôle within a matter of a few days or weeks.

The training status of the crucial thirty-seven Guard and Reserve divisions is such, however, as to require upward of six months' active-duty training for the Guard divisions and upward of ten months' training for the Reserve divisions before they could be committed to battle.

THE time lag between mobilization of our reserve divisions and achievement of a combat-ready status must be reduced to a maximum of three to five months if they are to meet the requirements of total atomic war.

Total strength of the Army National Guard and the Army Reserve participating in paid, regular drills is approximately 686,000 officers and men. Of these, 436,000 are in the National Guard and 250,000 in the Army Reserve. Strength of the 27 National Guard divisions averages 8,000 to 10,000 each. The remainder are spread among twenty-eight separate Armored Cavalry and Infantry regiments and a large number of antiaircraft, tank, artillery, medical, and logistical units.

The 10 Reserve divisions average about 4,000 each. An additional fourteen Reserve organizations carry divisional designations but are, in reality, training, logistical, and administrative commands.

Both the Guard and the "ready" por-

tion of the Army Reserve participate in 48 two-hour armory drills and one 15-day summer encampment each year. Staff and command personnel receive additional training in the form of week-end schools and command-post exercises. Officers and enlisted men of both components are eligible for training on active-duty status at Army service schools up to and including the Army War College.

The Army National Guard differs from the Army Reserve in that, although organized, trained, and inspected according to Federal regulations, it owes its primary allegiance to the Governors of the respective States and territories rather than to the President of the United States.

This is so only as long as the Guard remains in State status. In time of emergency, the President has the power to call the National Guard into Federal service. The President then becomes the Guard's commander in chief.

THE purpose behind this seemingly clumsy system lies in the Second Amendment to the Constitution—"A well-regulated Militia, being necessary to the security of a free State, the right of the people to keep and bear arms shall not be infringed."

The organization of the National Guard along State lines is aimed at keeping absolute military power out of the hands of the central government, except when a serious threat arises to the national security, and of decentralizing that power the moment the emergency has passed.

Any plan to streamline the reserve system must safeguard this cardinal principle. To do otherwise is to tamper with the foundations of our democratic government.

The National Guard traces its history back to the colonial militia, the first permanent unit of which was organized in 1636. That history has been a story of heroism, great achievement, and bitter failure, brought on by the failure of the colonies, and later of the Nation, to train, equip, feed, and pay the citizen-soldiers adequately, if at all.

Happily, the status of training in the National Guard has advanced far beyond the "ragged militia" of even twenty years ago. Training in the Guard today is administered through the National Guard Bureau in Washington, working closely with the Chiefs of Staff of the Army and the Air Force.

Guard officers, although still appointed by the State in accordance with the Constitution, must meet the same Federal standards as any officer of the Federal services.

Equipment, training aids, pay, uniforms, and general logistic support are provided the Guard on a basis comparable to that of the Regular Army.

No small part of the toughness and resilience characteristic of the present-day National Guard is due to the fact that each and every advance in training, equipment, pay, and general administration has been gained on the initiative of the Guard itself, all too often in the face of bitter opposition from those from whom the Guard had a right to expect help.

THE Army Reserve is a Federal, rather than a State organization. It takes its orders directly from the Chief of Staff of the Army rather than from the Adjutant General of the State.

Historically, the Army Reserve was created to provide a system of retaining the skills of the officers and men who could not be absorbed into the State militia. As a result, it now carries on its rolls a vast number of men in various categories of training and availability. Over a million and a half of these men have no more contact with the military than that their records are maintained by the military establishment and that they are subject to recall in an emergency.

The Army Reserve has been at its best in the creation and training of highly specialized units such as hospital and military-government teams whose members' civilian occupations are identical with their military rôle. It has been far less successful in dealing with combat-type organizations.

There is some justice in the belief by the National Guard that the combat-type units of the Army Reserve have been established in order to create a Federal Reserve system that will eventually supplant the National Guard.

This belief has been reënforced by the establishment of Army Reserve units and armories in localities where there was barely sufficient manpower to support the local National Guard unit.

Within the past two years a gargantuan effort has been made to increase enlisted strength under provisions of the Armed Forces Reserve Act of 1955.

One of the sharpest contrasts between the drawing power of the Army Reserve combat formations and those of the National Guard grew out of the Korean emergency.

National Guard divisions called to active duty in 1950 and 1951 with between 8,000 and 10,000 men each were returned to State control with but a fraction of that strength, due to expiration of enlistments while in Federal service.

None of the Army Reserve divisions was called to active duty during the Korean emergency. Their strength continued to average in the vicinity of 2,000 officers and men during the absence of the Guard divisions.

IN the three years since the end of the Korean emergency and the return of the Guard divisions to State control, Army Reserve divisional strength has been raised to about 4,000 officers and men each. The Guard divisions, starting from scratch, already have regained their former strength of 8,000 to 10,000 and are pushing beyond.

The cost of recruiting enlisted personnel for the Reserve divisions, as compared with recruiting for the Guard, has been excessive. Because of this there is reason to believe that, had comparable Federal support been available to the Guard, far greater results would have been achieved for each dollar spent.

Much of the reason for the lag in

"The great majority of National Guard officers are dedicated men who have made a career of Reserve affairs. . . . They are capable of discerning between what is possible with a unit of the Regular Army and a unit of part-time citizen soldiers."

Army Reserve division strength lies in the arbitrary control exercised throughout the Federal military Reserve system. In the great majority of cases, the capriciousness of this control has been quite unconscious. But its effects have been no less disastrous.

Changes in unit designations and total reorganization of other units have been made seemingly at whim. In time of emergency, key individuals have been called from a unit and the unit itself left to fare as best it could. Other units were called to active service and the commanding officers, who had organized and trained them, were left at home, branded as incompetents in the eyes of their fellow citizens.

MUCH of the difficulty can be traced to two factors: (1) Remoteness of policy-making headquarters from the units involved and (2) Assignment of individuals to those headquarters on a routine basis, with no special consideration given to the complexity of the Reserve problem.

The National Guard has been faced with the same problems as the Army Reserve. The Guard, however, has made every effort to prevent unnecessary changes in unit designation and in branch of service. It has, in addition, fought tooth and nail against the breakup of units either before or after recall to active duty.

Guardsmen have been no less resentful than Reservists at the breakup of their units after recall to active duty. But it was the knowledge that the Guard itself had done everything possible to prevent the breakup and had reconstituted the unit as soon as it was returned to State control that retained for the Guard the loyalty of its old troopers and won for it the allegiance of the recruit.

The great majority of National Guard officers at State level and at the National Guard Bureau are dedicated men who have made a career of reserve affairs. Most of them have served in every rank from private to field-grade officer and above. They understand the problems of that kingpin of the entire structure—the company commander. They are capable of discerning the fine line between what is possible with a unit of the Regular Army and what is possible with a unit composed of part-time citizen soldiers.

The success of these men in protecting National Guard units from being turned upside down with each change in command at some distant headquarters and the resultant close identification of the individual with his unit are the bedrock of the National Guard's strength.

The first step in improving the combat capability of our Army reserve components must be the elimination of the competition that now exists between the National Guard and the Army Reserve.

Whatever value there may be in this competition, it is outweighed by the duplication of effort and expense involved in the building and maintenance of two sets of armories and the unseemly squabble over recruits and public support between two groups wearing the same uniform.

The National Guard has demonstrated its ability to organize, train, and administer major combat formations. Given a reasonable length of time between wars, it has recruited those organizations to the very limit of the funds and facilities available.

These accomplishments, contrasted with the shortcomings of the Army Reserve, as regards large, combat-type units, would seem to make it reasonable that responsibility for such units be turned over to the Guard, *in toto*.

The Army Reserve, on the other hand, has demonstrated a capacity for organizing and training the myriad highly specialized technical and administrative units required in modern war.

Army Reserve schools for groups of officers not assigned to a unit but anxious to maintain their military proficiency have made a valuable contribution in keeping fresh vitally needed skills. In addition, the Army Reserve performs an important function in training, by means of correspondence courses, those individuals who find it impossible, due to geographic location or business interests, to participate in regular drills or meetings.

This is the area in which the Army Reserve can make its greatest contribution and to which its activities should be confined.

TRANSFER of the major Army Reserve combat units to the National Guard would involve a temporary disruption of training and administration. With a major reorganization of the Army impending, however, such disruption is inevitable. The reduction in size of the Infantry division and the shifts which will accompany that reduction provide an ideal opportunity for integrating the Reserve divisions into the National Guard.

No plan for solution of the military reserve problem, no matter how brilliantly conceived, can succeed until the useless rivalry between the National Guard and the Army Reserve is ended. The means are at hand for ending that rivalry without harm either to the individuals or to the basic constitutional values involved.

Whether or not the present clevage in Reserve ranks is healed, four major requirements must be met before our land-power reserve can approach an acceptable level of combat readiness: (1) Stabilization of personnel turnover; (2) Provision of active-duty basic training for all recruits without drying up sources of recruits in the process; (3) Improvement of individual physical conditioning; (4) Improvement and expansion of armories and related installations.

THE 6-month active-duty requirement now in effect for all Army reserve-component recruits, except those with prior service, appears unrealistic. The program has proved so expensive that it threatens to collapse completely in February, 1958 unless large new appropriations are made available.

Desirable as six months, or even a year of training would be, a shortened period of training of eleven or twelve weeks would seem to be the only one that can be supported on a long-range basis.

For over a generation the United States has sought a way around the need for an effective and equitable system of compulsory military service.

Compromise after compromise has been made. In the end, we have done the very thing we sought most to avoid by placing the principal burden for the Nation's defense upon the small group willing to assume it.

The time has come when we must face reality. If we are to depend on our Reserve components, and circumstances dictate that we must, then we must provide them with a stable source of trained recruits.

THE third major obstacle to a truly combat-ready Reserve is the low level of physical fitness among our civilians.

President Eisenhower has joined leaders in the fields of medicine, education, sports, and the military in expressing alarm over signs of physical deterioration among American youth. That deterioration has been brought about by the same force that constitutes America's greatest military strength—superior mechanization and technology.

There is little or no time available during the weekly drill, or even during summer field training for formal physical training. If National Guardsmen and Reservists are to be physically capable of bearing the burden of war without extensive active-duty training, then some basic reforms must be made in American life.

It is up to the home and the school to equip each individual with the habit of regular physical training, based on sound diet, adequate rest, and the sane use of liquor and tobacco.

Expansion of the present armory system and the replacement of old, inefficient structures remain of prime importance to the entire reserve establishment. All the effort spent in recruiting, equipping, and paying a man is lost if, when it comes time for him to receive his training, he can neither see the instructor because of dim lighting nor concentrate on the subject matter for trying to keep warm.

Sufficient funds have been appropriated during recent years to allow a considerable progress in improving the armory system. Year after year, however, power to obligate these funds has been withheld, apparently for reasons of economy.

Considering loss to the taxpayer in wasted training hours and damage to the national defense in the retarded training status of hundreds of Reserve component units, this is indeed a penny-wise and dollar-foolish economy.

Members of the Pennsylvania National Guard load and fire a 105-mm. howitzer as part of their annual training in summer maneuvers.

The solution to all these problems involves a consolidation and an expansion of the reserve program. Adoption of the recommendations would reduce, it is believed, the time necessary to train and equip a National Guard division from over six months to between three and five.

WHETHER readiness time could be reduced below that figure is doubtful in view of the fact that there are definite limitations on the amount of time citizen-soldiers can be expected to give to military training.

The average National Guard officer already devotes a minimum of two nights a week to his unit. The company commander may spend an hour or more each day, in addition to his regular drill night and administrative night, at the armory. For every hour spent giving instruction, the enlisted instructor must spend two to four hours in preparation, assuming he is already familiar with his subject.

The saturation point in Reserve training appears to be the addition of three weekend outdoor training periods to the regular weekly drill, summer encampment, and weekend CPX routine. Beyond that, all efforts must be directed toward improving the quality rather than the quantity of training.

Reserve affairs are, perhaps, even more complex than those of the Regular military establishment, for they involve the handling and training of men whose primary concern must remain that of providing a home and a livelihood for themselves and their families. The benefits to be obtained, however, are enormous. The savings to be realized by maintaining a single Infantry division in National Guard rather than Regular status are measured in millions of dollars each year.

A TRULY ready land-power reserve can be built. It will be built only when we as a nation cease deluding ourselves that we can build an effective military reserve without interrupting the soft-drink, hot-rod, and magnolia years of our youths. The greatest beneficiaries of that interruption will be the youths themselves.

Guided Missile Progress

The advent of the new weapons into our armed forces is leading to changes in military strategy, is dictating new tactical concepts, and is altering the disposition of our sea, land, and air strength

Rear Adm. John H. Sides

Admiral Sides is Deputy to the Special Assistant for Guided Missiles, Department of Defense, Washington, D. C. This address was given before a recent meeting of the Washington Post of the A.O.A.

WHEN one prepares to undertake a general discussion of the national guided-missile program, I believe it is a splendid idea to begin by backing off and taking a good look at this overgrown infant which has passed the spoon-feeding stage and which some people fear will, before long, eat us out of house and home.

Our program is just slightly over a decade old, and it literally started from scratch about the end of World War II. True, the Navy had developed and used sparingly the air-to-surface Bat, as well as a television-controlled robot plane, and the Air Corps had made some use of an explosive-laden drone, but it was the Japanese Kamikazes which attacked our fleet at Leyte Gulf and Okinawa which really spurred us on toward our modern missile program.

Today we have antiaircraft guns and fire-control systems which could handle the Kamikaze with the greatest of ease, but we couldn't cope with them too effectively in 1944 and 1945.

As a result, the Navy assembled a group of top technical officers and scientists and embarked upon the crash development of a surface-to-air guided missile. This was to be a relatively short program and we were going to take it out and surprise the Japanese the way we had done with the proximity fuze.

In retrospect, it seems impossible that so many smart people could have so grossly underestimated the task at hand; but we had very little knowledge in many of the fields covered in supersonic missilery. Radar was relatively new. Practically nothing was known of transsonic and supersonic aërodynamics. The turbojet was an infant. No ramjet had ever developed thrust at supersonic speeds. Most of our liquid-propellant know-how was gleaned from the Germans. Large-grain solid propellantry was unknown. The electronic industry was really just getting off the ground—and so on and on and on.

Today, we are in much better shape. Most of the voids have been filled by truly astounding progress in basic and fundamental research, and this has been applied, through pure sweat and heartaches and good hard work, to the point where we can take on a job with the confidence that we can finish it in less time, at less cost, and with little risk as to its successful completion.

After twelve years the programs of the Army, the Navy, and the Air Force have brought forth what is indeed a new industry—one whose scope and magnitude account for a very sizable slice of the defense budget, being reckoned not in millions but in billions of dollars annually—and growing year by year.

If one were to call the roll of the important aircraft and electronic companies, he surely would have named the key members who make up this new guided-missile industry. But he would merely have scratched the surface, for in addition to these prime contractors there are level upon level of subcontractors covering every imaginable product and numbering in the tens of thousands who also contribute importantly.

IT is interesting to note that, among our most important and successful missile projects, the prime contractor may be an airframe producer or an electronics company. Regardless of which may be the prime contractor, he usually finds it expedient to team up with the other to bring to bear the necessary sciences and skills to ensure an effective end item. Examples are Western Electric and Douglas in the Nike, Bendix and McDonnell in the Talos, Raytheon and Northrop in the Hawk, and so on.

In certain cases, however, this arrangement has not been followed, and a single prime contractor has undertaken the entire job. In the earlier days, at least, this philosophy had brought more or less intense critical reaction from the group which felt that a newcomer was

infringing upon its traditional field.

In general, the guided-missile programs have caused the various companies to assemble new kinds of staffs composed of very competent scientists and engineers in fields which cover almost every conceivable facet.

The environments of a supersonic missile in flight are an order of magnitude more stringent than those encountered heretofore. Vibrations covering a wide range of frequencies subject the various components to terrific accelerations; electronic components generate internal heat which must be dissipated while at the same time the skin friction with the atmosphere is generating more heat on the outside; increasing speeds are causing real problems with new heat-resistant materials and alloys which are difficult to form and to weld.

All these, and more, are working against us while the guided missile, by the very nature of the beast, requires reliabilities undreamed of in other fields. There is no crew present to make final adjustments in the air, and almost any malfunction, no matter how seemingly insignificant, will result in catastrophe to this one-shot, expensive article.

This new requirement for extreme reliability has led to a new brand of design, engineering, and production, which begins with the first "breadboard" and carries through all stages of research, development, fabrication, assembly, test, and checkout. It must consider maintainability by not-too-skilled technicians; it must consider the logistic considerations of the various services; and it must consider the operational problems of the man in the field or the fleet.

We read reams and reams about these very expensive new weapons of war, and I would be the last to insist that they are cheap. But we are asking these missiles to do jobs which cannot be accomplished by any other means.

The advent of the jet engine and of nuclear weapons has imposed a kind of threat which must be defeated. Modern high-performance airplanes simply cannot be brought down with antiaircraft artillery. As a result, we see the personnel of the Army's Antiaircraft Command being shifted over to man Nike battalions as rapidly as we get the new missile batteries on site. We see antiaircraft batteries of our combatant ships giving way to surface-to-air missile batteries of various types.

In the air-to-air field we find that our aircraft guns and unguided rockets with high-explosive warheads will no longer do the job. Two 600-knot planes approaching head on will close at the rate of a mile every three seconds. And in any other kind of approach there is very little likelihood that the interceptor can even reach an effective firing position.

This all boils down to the fact that we must have a supersonic missile with a range of several miles so that the effective firing envelope is greatly enlarged and so that this missile, which has a great speed advantage over the target, can make the final intercept. With such a missile, human reaction time is no longer important, and the preciseness of ground-control intercept equipment and techniques can be relaxed to within practicable limits.

THE fact that such missiles also can be fired upward at targets many thousands of feet above the firing aircraft also can influence the very designs of our interceptors by letting us optimize their performance for altitude where they are most efficient.

Air-to-surface missiles carrying powerful warheads will allow us to attack heavily defended enemy strong points without subjecting our bombers to concentrated local defenses. Attrition will be reduced greatly, and the life expectancy of the effective manned bomber will be prolonged for several years.

SURFACE-to-surface missiles run the gamut from short-range antitank weapons to intercontinental ballistic missiles and represent a family of weapons of ever-increasing importance to our armed services.

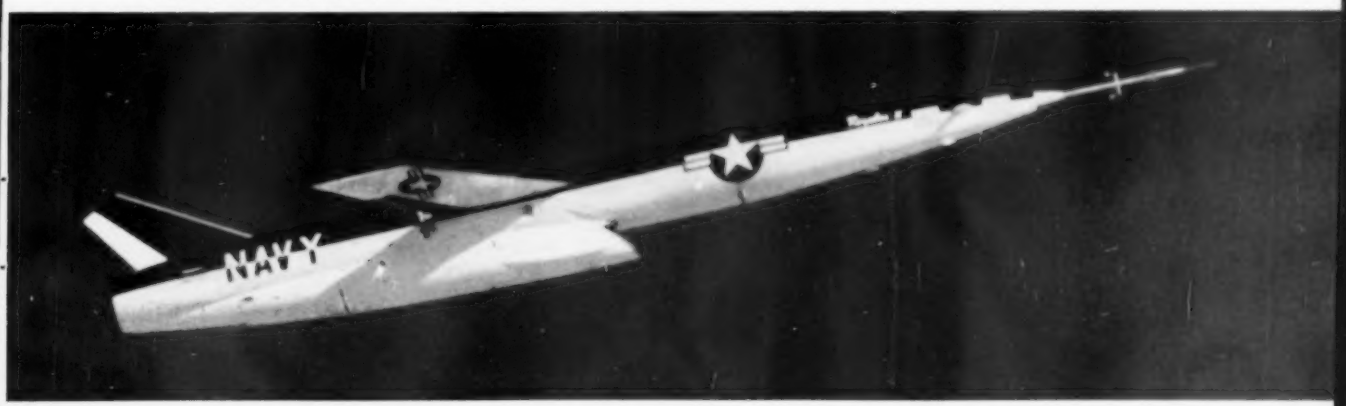
I have already mentioned that surface-to-air and air-to-air missiles are replacing, to a great extent, antiaircraft artillery and aircraft guns and rockets. We are approaching the day when surface-to-air missiles will begin to take the place of short-range interceptors as well.

I doubt that any of us will see the day when long-range interceptors will be made obsolete by missiles, but we shall certainly witness the beginnings of the substitution process. We shall also see our armies in the field furnishing more and more of their own tactical support, with a consequent reduction in the demand upon the Air Force for such support.

There has been a great deal of discussion during the past several months on the subject of Secretary Wilson's November 26th decisions, which usually are described as the "rôles and missions" decisions. These discussions usually have generated more heat than light.

I should like, first of all, to state plainly that these were *not* rôles and missions decisions. The rôles and missions of the services are contained in the National Security Act of 1947 and are a matter of law. Not one item of

Recently released photo of the Navy's supersonic Regulus II guided missile shows the flight test vehicle on a trial run.



Mr. Wilson's decision paper altered the rôles and missions by one iota.

What the Secretary is really doing is clarifying the responsibilities of the various services in so far as concerns the employment of guided missiles in support of their assigned functions so that we get the most offensive and defensive capabilities for our available defense budget dollar and so that unwarranted duplication is prevented, not only in research and development but in operational employment as well.

The ultimate goal is to ensure that, over all, we have in our combined Army-Navy-Air Force-Marine Corps arsenal the wherewithal to do the jobs which need to be done. It should not be necessary for each service to possess every capability as long as the Nation has the needed capabilities which can be brought to bear, usually under joint theater commanders, when and where they are needed.

I should like to emphasize briefly the importance of the weapon-system concept in so far as guided missiles are concerned. The best missile in the world is absolutely useless unless each portion of the entire system has been properly developed, is in place, and is functioning correctly when needed.

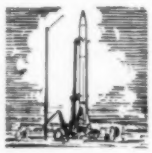
Take an air-to-air missile system as an example. The system as a whole consists of the airplane, its power plant, its instrument panel, its AI radar, its computers, its launching mechanism and firing circuits, the missile, its communication system with the ground, the ground-control-intercept equipment and personnel, and so on.

Beyond this there is the base and the entire logistic system which starts at the manufacturing plant and includes pipeline activities, depots, material-control systems, maintenance activities, and, most important of all, trained technical personnel.

I RECITE this long list not to confuse you but rather to indicate as forcefully as I can that the research and development program is only the beginning—and that it is by far the least expensive phase. The instant a decision is made to employ a system operationally we commit ourselves to huge expenditures and tremendous efforts across the board. This is the phase which the Nation simply cannot afford to duplicate except in certain well-considered instances.

A great to-do has often been made as to the expense of the new armament systems. They really are expensive, but not essentially more so than other systems that have been with us for years. And once they have become truly operational and have demonstrated their capabilities to the point of wholehearted acceptance by operational commanders, I am sure that we shall find that many of these guided missile systems will be, in fact, the least expensive methods of effectively accomplishing the tasks confronting us.

In those cases where missiles replace aircraft weapons systems we shall find



that annual operating costs will be greatly reduced as compared with the systems they replace. There will not be a requirement for daily proficiency flying, with the attendant large expenditures for jet fuel, airplane maintenance, and the like.

I would not attempt to predict the dates when this could happen. It will necessarily be an evolutionary process. It will probably first be felt in the field where surface-to-air missiles take over the load from short-range interceptors.

In the meantime we will be and are being faced with the necessity for going forward with the development of the new capabilities while at the same time continuing to maintain and improve our effectiveness with the old; and we must assure ourselves a military posture which will give us the ability to maintain deterrent and retaliatory forces, to engage successfully in all-out war in the unfortunate event that this is forced upon us, and at the same time to have the types of forces needed for quelling smaller and more local conflagrations should this be required.

Despite all our problems, it should be reassuring if we take a look at a few of our solid accomplishments and review briefly the list of those missile systems which are actually operational in the hands of our troops, airmen, sailors, and Marines.

In the surface-to-air field we have Nike Ajax battalions on site guarding a great many industrial complexes, population centers, and other important installations. Terrier has been added to the armament of the cruisers Boston and Canberra, the destroyer Gyatt, and is being installed in substantial numbers of new frigates under construction; the Marine Corps also has in commission Terrier antiaircraft battalions utilizing highly mobile equipment. Other missiles with greater potentialities are well along in development.

In the air-to-air field, Sparrow I and Sidewinder missiles are being employed by the fighter squadrons of our fleets. Falcon is being used by interceptor squadrons of the Air Force in continental air defense, and Sidewinders will soon be used for this purpose also.

In the air-to-surface category certain Navy patrol squadrons have been equipped with the Petrel missiles.

In the surface-to-surface field Army Corporal battalions and Air Force Matador squadrons are deployed overseas, and the Navy's Regulus is in operational use from submarines, cruisers, and carriers.

A great deal of information, not always factual, is appearing these days concerning the ICBM and the IRBM. I can only assure you that our progress is good, that flight testing is becoming a routine matter, and that these weapons systems employed from land and from the sea are certain to exert a profound influence upon international relations in the years to come.

The advent of missiles into the arsenals of our armed services is leading to changes in military strategy, is dictating new tactical concepts, and is changing tactical dispositions of fleets and tactical compositions of land forces and air forces. We are in an era of evolution wherein missiles have replaced certain older systems, and are supplementing and starting to replace certain other systems.

This evolutionary period will span many years, but one day we shall come to the realization that the evolution will in fact have been a revolution and that guided missiles are the most important contributor to the strength of our armed forces.

The New Army Rifle

The light 7.62-mm. weapon will replace four caliber .30 small arms

LONG before there was much talk about weapons systems, Army Ordnance started to plan a compact small-arms weapons systems to replace its large collection of hand-carried infantry weapons. That was in 1945, and now, following the recently unveiled M60 general-purpose machine gun, a standard rifle—the M14—has been approved.

The M60 replaces three types of caliber .30 machine guns presently in use. The new rifle basically will replace the four present types of caliber .30 small arms—the M1, the carbine, the M3 submachine gun, and the Browning automatic rifle. (More accurately, a heavy barreled version—the M15—will replace the BAR.)

Thus two small-caliber weapons for combat use will replace seven, and both will use the 7.62-mm. cartridge now adopted by our allies in NATO. Logistics, production, and combined operations are correspondingly simplified.

Never has such effort been devoted to small-arms development. This was an opportune period for the United States to pursue an orderly program, for we had the satisfactory battle-tried

Infantryman and new friend (Army photo).

M1 to use in case of an emergency while we sought the ideal rifle that could use the NATO cartridge and replace our variegated armory.

Competition between the Springfield Arsenal's final design, the T44, that developed from the original rifle planned in 1945, and Belgium's Fabrique Nationale (FN) rifle, designated T48 for tests, was carried on for almost six years.

A complete discussion of the two rifles, then under test, appeared in the May-June 1955 issue of ORDNANCE ("New Rifles for Old," by Capt. Charles B. Haslam, page 1002).

IN the final analysis the T44 got the nod because of its lighter weight and greater suitability for American mass production and training. When the T44 goes into service it will be issued with a light barrel as the M14 and with a heavy barrel and tripod as the M15 (shown at bottom of page). The M14 at 8.7 pounds will be one pound lighter than the M1, and the M15 at 14.1 pounds will be 6.7 pounds lighter than the BAR.

The M14 has a 22-inch barrel, slotted flash hider, and a change lever that permits automatic or semiautomatic fire. The 20-round magazine may be loaded from clips through the top of the receiver or by attaching a loaded box magazine underneath. The adjustable rear sight is similar to that of the M1.

All who have fired the M14 have been pleased with its handling qualities and are convinced that our ground forces will have a weapon ideally suited to the American fighting man.

Industrial Survival

Unless proper measures are taken to protect our domestic mobilization base from all-out attack American industry might be crippled so badly that a war would be lost before the Nation could retaliate in force

Virgil L. Couch

THE world is in an era of great danger. In order to maintain peace through strength and, should attack occur, to be able to recover quickly, we must give a great deal more time and thought than we have in the past to the protection of our domestic mobilization base.

In any future war, industry, its factories, its workers and their families would be a target of enemy bombers. Unless through proper protective measures the effects of that first all-out attack could be blunted, our key industrial concentrations could be crippled so badly that we might lose a war before we could strike a blow in our own defense.

If such disaster should occur, there would be no need for industrial mobilization plans for there would be no industry to mobilize. We must, therefore, protect our domestic mobilization base by planning to minimize the effects of attack. This calls for a strong civil-defense program at the workplace.

Planning for civil defense and planning for industrial mobilization and production are closely related. Much has been done toward building our mobilization base and ensuring its maintenance, but all our efforts in building and maintaining this base can be rendered almost useless unless action is taken to protect it.

Many industrial organizations already have taken certain disaster precautions. However, every industry must work continuously on plans to overcome production interruptions due to attack damage. There is no question but that this work must be broadened and intensified.

Mr. Couch is Director of the Industry Office of the Federal Civil Defense Administration, Battle Creek, Mich.

It is clear that there can be no one plan which will meet the requirements of all companies and plants. However, with information gathered from Hiroshima and Nagasaki, from the A-bomb and H-bomb tests, and from the thinking of many industrial executives who have already made certain disaster preparations within their companies and plants, we can suggest certain elements of a survival program which can be tailored to fit each company and plant situation.

What are some of the typical actions which industrial management can take to minimize the effects of attack—to protect the domestic mobilization base and give greater assurance of production continuity?

1. *Establish company and plant leadership responsibility for disaster preparedness.*

The first step in the actual preparation for disaster is the appointment of a *single individual* at both the company level and in each plant—a disaster planning coördinator—to provide coördination and direction of the over-all corporate disaster plan and each plant disaster plan.

At both the company and plant level a disaster advisory committee should be designated to assist in the development of the various phases of the disaster planning program.

It is imperative that coördinators and committee members maintain close liaison with civil-defense officials. They should become thoroughly familiar with the authority, organization, and emergency procedures which are established by law and become effective upon declaration of an emergency by the President or Congress.

Coördinators, committee members, and service chiefs may obtain valuable information and training by attending the FCDA Staff College course in industry defense at Battle Creek, Mich., and other FCDA courses. A great variety of publications also are available.

2. *Disperse new industrial plants.*

Obviously the best defense method for protecting our domestic mobilization base and ensuring survival is industrial dispersion. This is the employment of the simple military measure of using space and topography for defense of industrial plants against attack. Adequate dispersion will create a multiplicity of targets and reduce the

relative vulnerability of any one concentration of industrial production.

3. *Deconcentrate critical production.* When production of essential items is concentrated geographically, an inviting target is offered to the enemy for inflicting the greatest amount of industrial injury in a given attack. Deconcentration refers to the geographic decentralization of critical production so that all manufacture of a critical item is not in one location.

Planning should provide not only relocation of the key production of critical items to other plants in other geographical areas but also relocation of key departments of a critical plant or facility, including the management and technical offices.

4. *Establish a plant security system for prevention of sabotage and espionage.*

Sabotage is an effective means of attack. Therefore, industry should take appropriate measures to prevent the commission by misguided persons or enemy agents of any destructive act to impair the productive ability of the plant. Measures also are needed to prevent the collection of information which might contribute to the enemy's knowledge of the Nation's war potential. Such information might be used to advantage by an enemy in attacking this country either through direct or covert means.

5. *Plan for continuity of management.*

This is an important part of disaster planning. No company is better than the people who make it work. If a company or plant is to continue production during and following attack, its key jobs must be filled. Succession lists should be prepared for each key position. Such lists must indicate the name of several alternates who would take over should a key official be killed or given other assignments as the result of attack.

6. *Establish alternate corporate headquarters.*

If continuity of management is to be effective, managers must have a place to assemble and work which is equipped and furnished for carrying on corporate operations during and after attack. It is desirable that such a headquarters be at a point where the company already has an installation. However, it should not be in a critical target area.

Additional or secondary emergency reporting points should be established for all personnel. One company has set up reporting centers at the homes of executive personnel who reside in suburban areas. Certain records are maintained at these locations and arrangements have been made for priority telephone service in an emergency. The cost of this type of planning is insignificant when compared with the activities of recovery-planning which can be conducted at these locations during or after the emergency.

7. *Protect vital records and documents.*

Protection of vital records includes the duplication and safe storage of records important to the continuation of the company and plant production. It is important that written descriptions of activities, manufacturing processes, engineering designs, and vital legal documents and accounting records be preserved and available to management after an attack.

One firm has described the disabling results of a loss of vital records as "corporate amnesia." Records protection is one of the easiest concrete precautions a company can take and might well be among first steps in disaster planning.

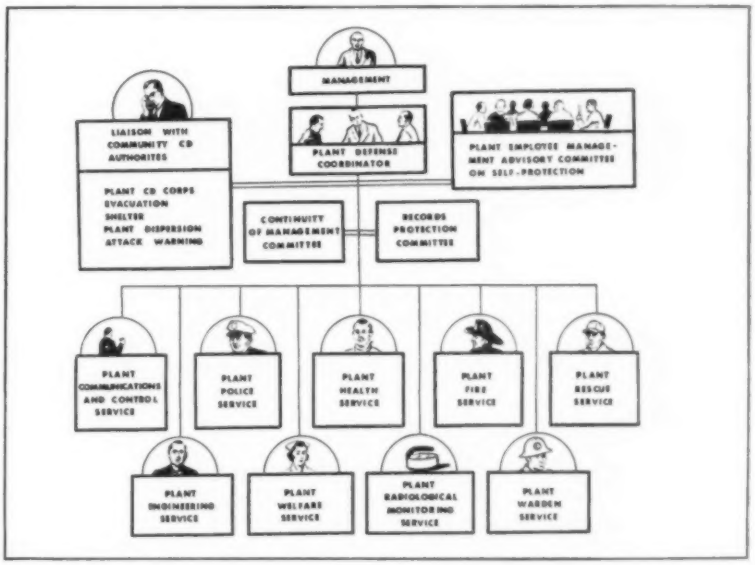
8. *Develop emergency financial procedures.*

Money may be needed promptly following attack for wage payment, cash advances to employees, payment of bills, and purchase of survival items such as medicines, food, and equipment. Some companies maintain bank accounts of an unrestricted nature at scattered locations and have established lines of credit at a variety of places.

Emergency procedures for drawing company funds should be developed in advance. Banking arrangements should be adequate and the corporate by-laws should have ample provisions for withdrawal of funds. A list of depositories in which the company has its funds should be kept current and on file in the company record storage vaults. In some instances it may be desirable to deposit a small amount of cash at the alternate company headquarters and in each of the security storage vaults.

The Federal Reserve System, in coöperation with the United States Treasury, Comptroller of the Currency, Federal Deposit Insurance Corporation, Office of Defense Mobilization, the Federal Civil Defense Administration, and

Organization for civil defense within an industrial plant.



other agencies, is developing plans and providing guidance and assistance to banks which will do much to ensure the continuity of money and banking after an attack.

9. *Plan for evacuation of industrial plants.*

Movement of civilians from dangerous and potentially dangerous areas in time of civil-defense emergency requires thorough organization, timing, and supervision. Great confusion can result from the spontaneous and rapid movement of employees when not properly directed.

A rendezvous point must be designated at a safe distance from the plant and arrangements made to receive and care for employees. A general traffic plan, both within and outside the plant, must be made, directional and other information signs and instructions posted, and adequate transportation provided.

It should be kept in mind that we will *never* have definite assurance of a *specific amount of warning time*. Therefore, we must be able to move fast when it is clear that there is sufficient time for evacuation.

10. *Provide shelters for employees.*

If there is not sufficient warning time to evacuate the plant, the only alternative is to take shelter. There is still need for shelter from blast, radiation, and heat effects on the fringe areas of damage.

Industries should designate areas within the plant where employees may be protected from the effects of an attack. Build deeper and stronger-walled basements, with thicker and stronger first-floor slabs, or construct separate underground shelters. Provide emergency power and sanitation facilities, filtered ventilation, food, water, and emergency medical supplies.

11. *Organize a plant civil-defense corps.*

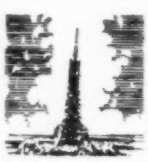
Such an organization is the basis for all self-help in time of emergency. Organize, train, and equip small groups within the plant and main office buildings for performing specialized services such as police, fire fighting, rescue, welfare, warden, radiological monitoring, medical, and first aid. In most plants such protective services as fire brigades, guard services, rescue teams, and first-aid facilities are already established.

The plant civil-defense corps is a part of the community civil-defense corps. Planning, training, and test exercises should be conducted in coöperation with community officials.

12. *Establish a plant warning and communication system.*

A plant control room should be set up with communications to the nearest civil-defense control center. Arrangements should be made to receive the warning alert and quickly to disseminate warning and information to employees throughout the plant and to communicate with civil-defense officials during and following attack.

13. *Prepare emergency shutdown procedures.*



In some instances, due to the manufacturing processes, disorderly shutdown could result in self-destruction of the plant—destruction as great as that resulting from an attack. Procedures must be planned and tested. Mock shutdown training exercises are conducted regularly in many plants.

14. *Establish industrial mutual-aid associations.*

This type association is an organization of officials of a group of industrial plants or utilities in an area or community, united by a reciprocal agreement to provide assistance to each other in disaster in the form of equipment and personnel.

Although industrial mutual-aid associations are not new, the idea is especially applicable to civil defense for dealing with wartime and natural disaster problems.

15. *Plan for emergency repair and restoration.*

An important part of disaster planning, this consists of activities necessary to assess and repair damage and restore communications, services, power, and production quickly. It includes the organization and training of special groups for repair of the industrial plant itself and electric, communications, gas and water services, etc.

16. *Prepare corporate and plant disaster plan manuals.*

Put the corporate and plant civil-defense plans in writing. Describe the purpose of the plans and the nature and responsibilities of each protective service, list the team leaders and members, outline the emergency procedures for each leader and team, show floor plans with shelter locations, etc.

17. *Prepare handbooks for employees.*

Tell all employees about the emergency plan at the workplace. Include information regarding the company plan, the alert warning, floor plan drawings showing shelter areas and hazardous points within the plant, maps showing evacuation movement routes within the plant and State.

18. *Urge all employees to prepare themselves, their families and homes for survival.*

If an attack occurs while employees are at home rather than at work, they must know the neighborhood civil-defense plan.

19. *Support and assist the community civil-defense efforts.*

Coöperate with the mayor and civil defense director by participating in national exercises and programs such as the annual Operation Alert and Civil Defense Week.

20. *Tell stockholders about the company civil-defense plans.*

Some companies include information in annual and quarterly reports to stockholders and some have included this information in advertisements.

We must protect our domestic mobilization base and plan for industrial survival and continuity of production. The solution to such a complex problem of this magnitude must come from industry itself. Government stands ready to assist, but the job is largely one for industry alone.

Air Force Firepower

A.O.A. Holds Thirty-ninth Annual Meeting at Eglin Air Force Base, Fla.

BOMBS away! This cry has many ramifications in this age of nuclear weapons as 800 members of the A.O.A. discovered at the Thirty-ninth Annual Meeting of the Association at Eglin Air Force Base, Fla., on May 6, 1957. Toss bombing, for example, by supersonic attack aircraft and the B-47 bomber alone was a demonstration worth attendance at the meeting.

The Air Force graciously made it possible for A.O.A. members to hold their annual meeting at Eglin and there to witness the Air Firepower Demonstration at the Air Proving Ground. This amazing demonstration is conducted semi-annually for the Joint Civilian Orientation Conference, a Department of Defense advisory group.

A.O.A. headquarters were established the preceding day in Pensacola at the San Carlos Hotel, fifty miles west of Eglin. Members flocked in by automobile, train, and private or commercial aircraft to go by specially chartered A.O.A. buses from Pensacola to the Air Base on May 6th, and some large groups flew directly to the main field at Eglin.

At the base athletic stadium, the rallying point for the A.O.A., a large committee from the Florida Post was on hand to greet the members.

Here buses were reloaded to tour the static exhibits on the hardstands including the latest types of aircraft and equipment under operational test at the proving ground. Visits also were arranged to the huge climatic hangar and other important points of interest.

At eleven o'clock all members returned to Foster Stadium to be served an excellent box luncheon including much-welcomed cool drinks.

By noon, twenty-three busloads were under way for the demonstration stands eighteen miles away on Range 52.

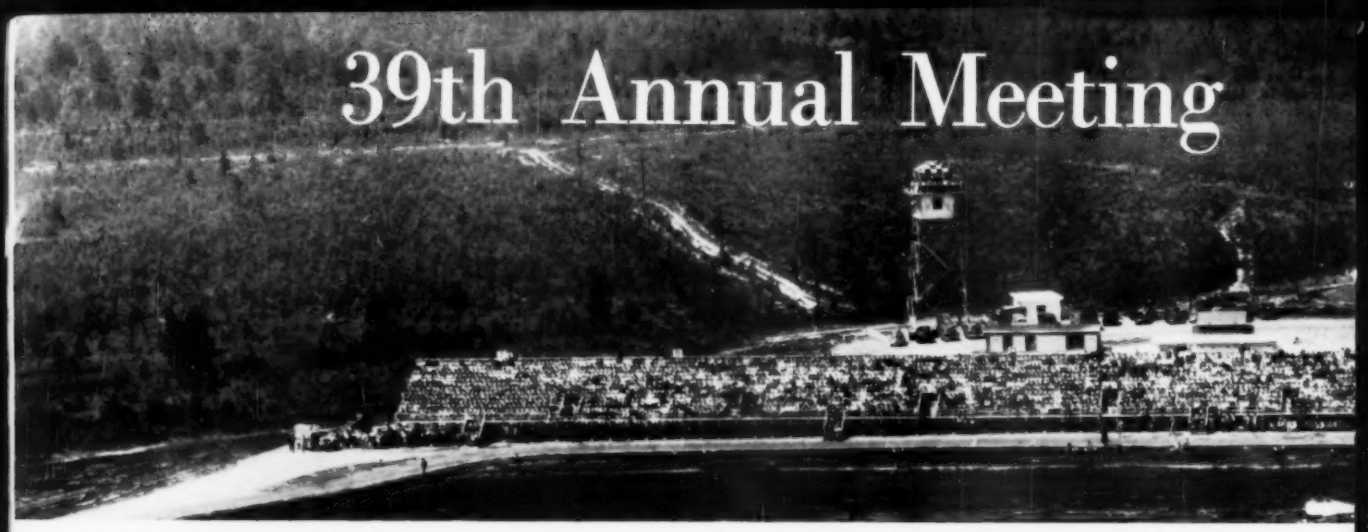
The schedule of events was opened by Maj. Gen. R. W. Burns, Air Proving Ground Commander, who welcomed the assemblage of 6,500, and extolled the achievements of the Air Force. Brig. Gen. John P. Henebry U.S.A.F.R., also spoke in recognition of the golden anniversary of the Air Force. The next two hours were replete with the roar and whine of jet engines and the crash of bombs, rockets, and machine-gun fire.

Some of the spectacular demonstrations were the precision flying of the 4-plane Thunderbird team in F-100 supersonic jets; the strafing, bombing, and rocket attacks on targets in front of the stands; and toss bombing of simulated atomic weapons. The final event was a bombing run at 5,000 feet by a B-36 that laid a line of 500-pound bombs about a mile long.

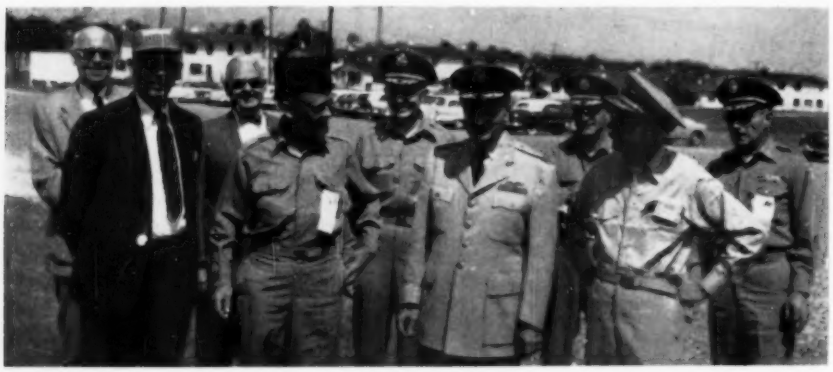
OF special delight to all Ordnancemen was a comparative demonstration of early and new aircraft machine guns from the slow fire of the World War I Browning to the fabulous rate of the Vulcan Gatling-type gun that fired a hundred rounds almost instantaneously.

The technique of toss and over-the-shoulder bombing was beautifully demonstrated by an F-84, F-100, F-101, and, of unusual interest, a B-47. In each run the plane's path was described by white smoke and that of the bomb in red smoke to its air burst over the target. The two colored trails were mute evidence that the attacking aircraft would have been clear of the blast from a real A-bomb.

39th Annual Meeting

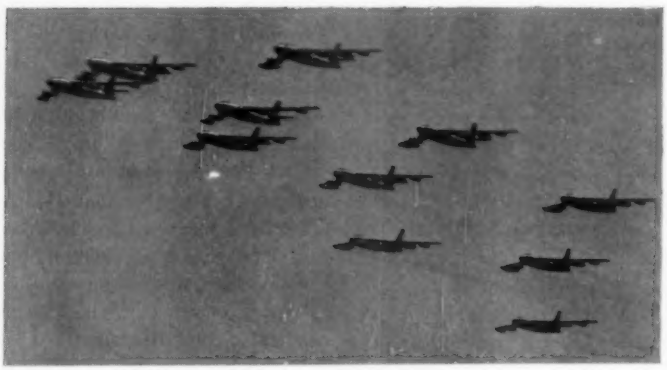


The above photograph of the A.O.A. members and other guests attending the 39th Annual Meeting was taken from an RF-84F photo-reconnaissance airplane flying by the stands at a speed of 400 miles an hour and an altitude of only 230 feet.



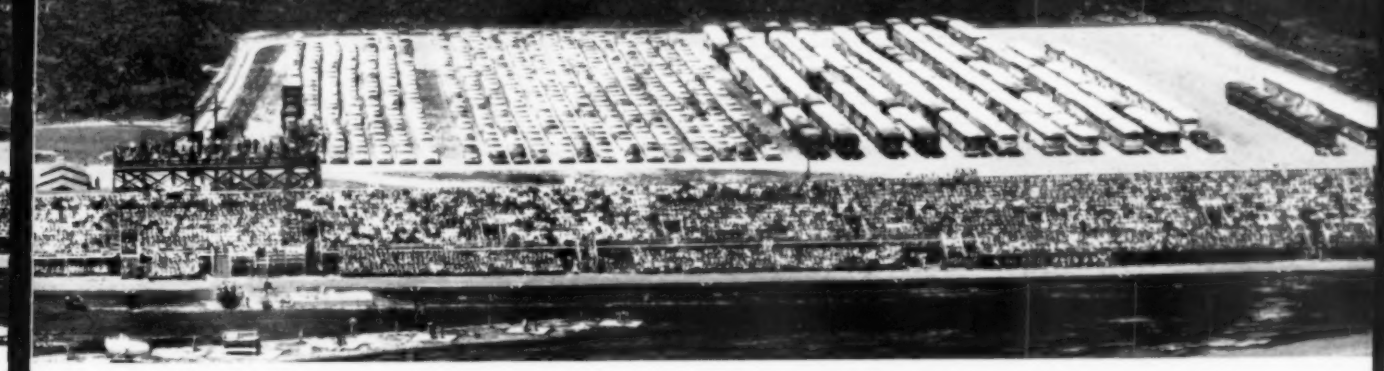
Among those present at the 39th Annual A.O.A. Meeting at Eglin Air Force Base were: front row, left to right: Col. Henry N. Marsh, general chairman, A.O.A. Technical Divisions; Lieut. Gen. Emerson L. Cummings, Chief of Army Ordnance; Maj. Gen. Edward P. Mechling, Commander, Air Force Armament Center; and Rear Adm. Frederic S. Withington, Chief of the Bureau of Ordnance, U. S. Navy.

Target aircraft in front of the stands burst into flames as they were strafed with machine guns and rockets from modern supersonic fighter aircraft.



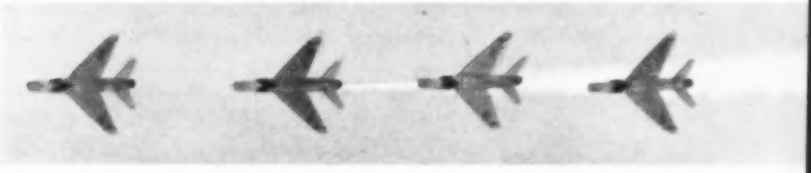
A formation of B-47 medium bombers flies by, above, while simulated gun batteries, below, are attacked with napalm bombs dropped from F-84F fighter aircraft.

Eglin Air Force Base



This photograph was taken at Range 52 at Eglin Air Force Base where the aërial firepower demonstration was conducted before an audience of more than 6,500 military and civilians who came from all parts of the country to witness the tests.

An F-100, above, gives a demonstration of the new toss-bombing technique for use with nuclear weapons. Here the airplane releases a 1,000-general purpose bomb at an angle of 90 degrees, then rolls out at the top of a loop.



The Thunderbird precision flying team, above, right and left, gives a thrilling exhibition as the F-100's dive down in single file, then pull up in a steep climb, separating at the top in a "bomb-burst" maneuver. The huge static display below included almost every type of operational Air Force aircraft. A.O.A. members also visited the huge Climatic Hangar. (All Air Force photos.)

Cross-country Mobility

The science of land-locomotion mechanics must be developed so that military vehicles designed for off-road travel may reach the state of efficiency that has been achieved by other forms of locomotion

Lieut. Col. M. G. Bekker

OBJECTS moving in a given medium normally show a tendency to assume forms which would offer least resistance to motion. A sleek smooth form is usually better than a stubby rough shape.

Such a trend may be seen in the evolution of the animal world as well as in the world of technology, and the described change of forms in living organisms as well as in man-made vehicles may be considered an important measure of progress in locomotion.

There seems to be no better illustration of that progress than a comparison between the amorphous shape of an amoeba and the streamlined forms of fish. In the field of motor transport, a similar illustration would be provided by the comparison between a prehistoric wooden cart and the aërodynamic form of a modern racing car.

IN general, one may assume that the adaptation of form to the environment of locomotion becomes more perfect as the organism becomes more advanced, and this adaptation may therefore be considered a measure of the degree of progress made. Hence a lack of such adaptation may mean either a fairly primitive stage of development or a development which represents an accomplished cycle of evolution, if it does not evolve further morphologically.

When such a criterion is applied to automotive equipment, one conclusion appears inevitable: both highway and off-road vehicles have displayed a rather slow change of basic forms for a longer period than the last quarter of a century.

Colonel Bekker (Canadian Army, Ret.) is technical director of the Land Locomotion Research Branch, Ordnance Tank-Automotive Command, Center Line, Mich.

The earliest history of the automobile, however, shows a transition period during which a primitive carriage fitted with the gasoline engine of about 1900 evolved into the "dream car" of 1957 and went through an almost complete cycle of form change within the 1920's and early 1930's.

However, a similar survey of what may be called military cross-country vehicles will not disclose a comparable evolution. In addition, it will be noted that while the automobile form is almost perfectly adapted to its environment of locomotion, which is a smooth highway and the surrounding air, the form of an off-road vehicle is, generally speaking, not adapted to operation in its own environment composed mainly of dirt, mud, snow, and rough ground surface.

This is illustrated by the fact that off-the-road vehicles are wide and short rather than narrow and long and that they have "bellies" which bog them down while protruding parts plow through soft ground at a relatively low sinkage. The form of tracks and wheels does not vary beyond the standards established a long time ago, not necessarily for off-the-road but rather for highway operation. As a result, diametrically opposed solutions are to be found applied for the same purpose, thus raising doubt as to the wisdom of the attempted evolution of form.

SUCH important questions as what the optimum form of the bearing area of a track or pneumatic tire may be, whether that area should be long and narrow or short and wide, continuous or discontinuous, only recently have been recognized as fundamental questions of vehicle design.

If it is realized that a tracked vehicle, looked upon from above, appears enclosed in a rectangle with an almost constant length-width ratio and that this ratio has not changed for the past fifty years, one must conclude that the true morphological adaptation of the off-road vehicle to the environment of its operation has not yet commenced.

Is it then illogical to conclude that, whereas the evolution of an automobile has reached the leveling-off part of the curve of perfection after having undergone a complete cycle of morphological change, the off-road vehicle has not yet begun to develop?

Recent studies indicate that this definitely may be the case, for the future increase in car mobility seems to depend

more on improvement of a system of superhighways, automatic traffic control, etc., than on the development of new power plants or new forms.

On the other hand, a purely morphological change in off-road vehicles may radically increase their mobility without much technological change in present power trains, suspensions, and running gears.

This potentiality opens a wide field for exploration and may lead to a rational study of the relationship between vehicle forms and the environment of locomotion. The introduction of such study is the logical outcome of any serious work on land mobility.

To improve vehicle mobility in the air and on the sea, the study of fluid mechanics has evolved into highly specialized branches of theoretical mechanics known as aërodynamics and hydrodynamics. Hence land transport —which for centuries has emphasized the road rather than the vehicle by employing soil mechanics and hydraulics to make better railroads, highways, canals, bridges, airports, and harbors— also needs the development of a discipline similar in concept to fluid mechanics in order to improve the land vehicle.

SINCE the empirical approach, so far only available to improve designs of motor vehicles, apparently did not lead to a satisfactory solution and stirred little permanent interest in the automotive profession, this more theoretical school of thought remains as the only hope of a radical change in the present situation.

This is particularly pertinent to the academic studies of automotive engineering which, with its present curriculum based on practical know-how and the thermodynamics of internal-combustion engines, provide a weak basis upon which to reverse the diminishing returns that prevail in purely technological automotive research.

New motors, fuels, lubricants, and new transmissions so far have repaid only a small fraction of the effort expended, as far as land mobility is concerned.

There appears to be little doubt that the development of what may become the mechanics of land locomotion, designed to shape properly the form and size of off-the-road vehicles, is the primary task of modern land locomotion. Such a task, however, falls far beyond the capabilities of a single group or organization and requires a nationwide coöperation of industry and the universities. Automotive engineers need the assistance of their Von Karmans, Froudes, Reynoldses, and Machs. If people of such caliber are not available, then the whole problem becomes an educational one rather than one of "organizing" a new research.

The first step within the premises expounded in the foregoing lines was made by the Army Ordnance Corps through the establishment of the Land Locomotion Research Branch at the Ordnance Tank-Automotive Command. Although done on a small scale, this action appears to have attracted enough attention to stir interest in more theoretically minded people.

The University of Michigan College of Engineering has opened a possible nucleus for another land-locomotion research laboratory and is starting new courses on land-locomotion mechanics within the automotive engineering curriculum. The Office of Ordnance Research at Duke University is sponsoring research work by graduate students and is encouraging interest in this field by generous grants.

These actions indicate that considerable progress has been made during the past few years in the philosophy of attacking the problem. However, if it is realized that the lift-drag ratio of an airplane wing was first defined in terms of aërodynamics some forty years ago whereas the load-drag ratio of a wheel has not been sufficiently determined in terms of soil mechanics even today, then the situation should be viewed with concern.

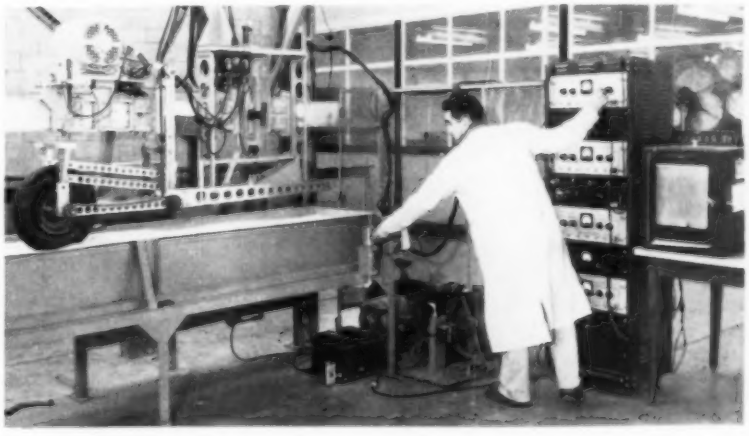
One must concede that remedial action is long overdue if the need for more mobility on land is as important as emphasized by other writers in ORDNANCE magazine.

HOWEVER the establishment of a theoretical background of land locomotion, the publication of as yet nonexisting textbooks and technical literature on the subject, and the education of a new generation of graduate automotive engineers (no degrees in automotive engineering are currently offered) would not solve the ultimate problem of rationally selecting and assessing various land-locomotion concepts and designs.

The mechanics of land locomotion may enable the engineer to design only an optimum vehicle for operation in the given environment. It is well-known, however, that such an optimum cannot be universal and what is good in Terrain A may be bad in Terrain B, or perhaps vice versa.

Thus the designer would inevitably find that, in order fully to satisfy all the user's requirements, not one but a number of solutions may be required.

Small-scale vehicle model is tested in soil bin equipped with dynamometric carriage at the Land Locomotion Research Branch, Tank-Automotive Command.



Such solutions would have to be evaluated with reference to various terrain types as specified in general requirements.

Hence, apart from the establishment of land-locomotion mechanics, the introduction of analyses of various soil-vehicle systems appears mandatory in order to rationalize methods of research and development work leading from requirements to the decision of approval or rejection of the given solution. This would result in a more scientific research and development program in which empirics would be supplemented with more general quantitative methods.

A need for such an approach appears urgent. The present development of better vehicles usually starts with the formulation of requirements by the user, rather than with the discovery of a new optimum solution by a researcher. As there is no recognized theory of locomotion and method of its evaluation, such requirements are necessarily based on the empirics of past individual experience.

Since the user of a vehicle is not primarily a researcher or an engineer in the pertinent lines of automotive engineering, any extrapolation of his experience into the future is limited. His requirements usually call for a mere rearrangement of existing elements rather than for the creation of new ones.

Moreover, the user so far does not have at his disposal satisfactory quantitative methods or yardsticks by which to state his requirements. When he speaks of performance in soft plastic clay or sandy loam, for instance, the designer cannot know what the user actually has in mind as there is an infinite variety of soft clays and sandy grounds with practically no parameters to describe them and occurring with an unknown frequency of distribution.

UNDER these circumstances the relationship between the user and designer has seldom been marked by a mutual understanding. The former is almost invariably dissatisfied with the degree of fulfillment of his requirements while the latter affirms that this is the best that can be done.

To avoid such a situation the designer often presents a number of alternatives and expects the user to decide off-hand or by means of an "ad hoc" organized field test which one should be developed—as if such a decision conceivably could be made without any general theory, extensive computations, laboratory and appropriate field analyses.

As was mentioned previously, such a problem cannot be solved through the establishment of the mechanics of land locomotion alone, although this would

rationalize and formalize the requirements by the user and would make them more unequivocal to the designer, so that they both would speak the same language.

Assuming, that the user can formulate the requirement, by indicating where and how he wants to operate in terms of definite physical and geometrical properties of the environment, the designer by virtue of his function is in no position to compromise the usually conflicting requirements of vehicle use and cannot select the optimum for over-all efficiency in A or B or more areas.

He also normally cannot assess the frequency of occurrence of important situations or their disadvantages and merits with reference to the over-all requirement. The problem of optimization, which thus becomes inevitable, requires the use of other than engineering methods and the mastery of other disciplines than those in which the vehicle designer was trained.

Since similar if not identical tasks (where conflicting factors involve sub-optimization, determining of exchange ratios, statistics and probabilities) have been performed by what is now recognized as operations research, the introduction of the respective discipline on a research and development level is recognized as inevitable.

The lack of this approach on the level of engineering development and purely mechanistic evaluation of various vehicle-terrain systems usually leads to misleading solutions in which extremes instead of operational medians are suggested as the optimum.

An example of such an outcome may be found in the field of track-versus-tire selection. Although there is no question that certain spectacular conditions may require the extremes as being the best solutions, one may seriously doubt if any of these extremes are valid in less dramatic but more frequently prevailing conditions.

It may be argued that the more specific pursuit of the operational analysis of terrain-vehicle systems has not been possible thus far because of the lack of theoretical methods and physical criteria of terrain and vehicle evaluation. This would be quite correct, for the operations analyst must have numbers available in respect to vehicle performance and soil trafficability instead of qualitative values and arbitrary "indices."

With the establishment of land-locomotion mechanics, however, these methods and values would certainly be made available, and a more rational exploration leading to soil evaluation from the trafficability viewpoint would be quite possible.

THUS, the development of an operational study of land locomotion does constitute not only a natural consequence of the development of land locomotion mechanics but also constitutes a replacement for the missing link in a chain of operations looking for more mobile vehicles.

It also relieves the designer from the impossible task of supplying proof that the solution he offers is the best one, and it relieves the user from formulating requirements as to what he really wants and to which he cannot possibly reply to the full satisfaction of those who must make the best decision.

The problems of this type, however, cannot be solved immediately as they require time and much effort. The complete solution must often wait until appropriate methods, equipment, and properly trained personnel are made available.

Mobility on land, like mobility in the air and on the sea, cannot be improved without the fully coördinated action of industry and the universities and without the establishment or introduction of new intellectual tools of progress as successfully employed in other fields of locomotion.

The New Soviet Weapons

The Reds do not regard guns and shells as "old" or nuclear weapons and missiles as "new" but as mutually complementary elements of a modern defensive and offensive system constantly kept up to date

Garrett Underhill

NEARLY four years ago there appeared in ORDNANCE an article entitled "New Soviet Weapons? It warned:

"This year—1953—is about the eighth year after the current Soviet rearmament program got under way. By the time-interval standards of the 1930's, its 'New Model Time'—time to replace old-model army weapons with the latest military styles in each conventional weapons category" (September-October 1953 issue).

Subsequent events have translated this warning into a grim reality. The Soviets not only have produced but have openly exhibited a whole new "family" of infantry small arms. They have come out with a complete new line of field artillery.

In view of the fact that the guided missile is generally regarded in the West as replacing the heavy antiaircraft cannon, what is especially remarkable is that the Soviets' new arsenal of "flak" weapons includes a newer and still heavier cannon than the big new one to which attention was drawn in 1953.

The 1953 warning that "'families' of powerful new arms may exist behind the Iron Curtain" was pointed up by detailing the tank situation. It was said:

"For some years now our tendency has been to compare America's new (even projected) weapons with those the Reds are known to have in general service. Thus the new Patton medium tanks are matched against the Reds' medium T-34; the U. S. heavy T-43 tank is compared with the Reds' Stalin . . . Instead of deriving intense satisfaction by comparing our 1950-1951 tanks to these patriarchs of the tank world, Americans should be worried. They should be gravely concerned as to what bald-headed Morosov and balding Kotin have been developing in the way of new and original designs, since they surprised the world years ago with their original T-34 and KV designs." (The Stalin is a development of the KV.)

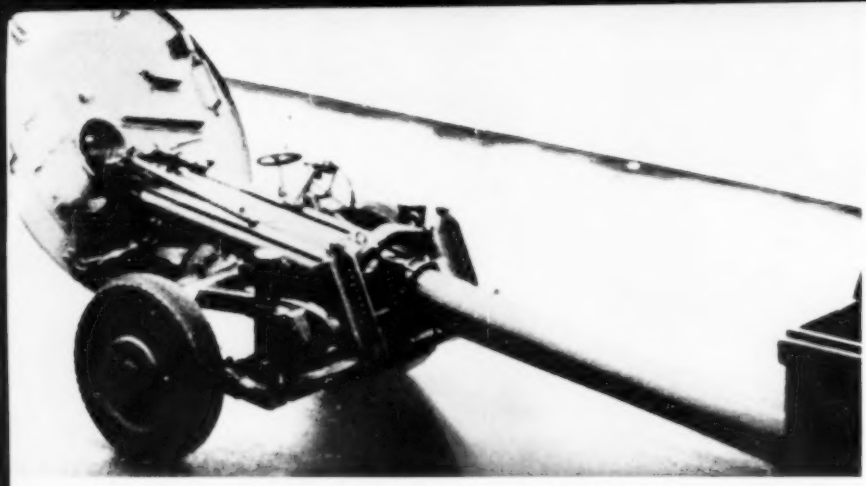
Mr. Underhill served with the Army Intelligence Corps in both the Second World War and the Korean emergency. He is a recognized authority on military weapons.

It turned out that there was good reason for Americans to worry. In the first part of 1955 the twenty-two Soviet tank and mechanized divisions in East Germany were reëquipped with the new T-54 tank. When in 1956 first-line Soviet Army divisions poured into Hungary from behind Russia's own borders to suppress the Budapest freedom fighters, they demonstrated not only that reëquipment with the T-54 was widespread throughout the Soviet forces but also that Soviet tank designers hadn't lost their fine engineering hand.

On the T-54, while increasing weight only one-half to four tons over the 35½-ton T-34, they have effected an up-gunning from a medium 85-mm. to a heavy 100-mm. gun. In the process they have managed drastically to reduce the comparatively high gun turret created for the 85-mm. gun. That turret has raised the T-34's silhouette and made the tank more noticeable and vulnerable than in the original version. They now have substituted a mushroom-shaped turret like the Stalin III's, affording the new and powerful tank a very squat appearance and probably less vulnerability to the blast and other effects of atomic weapons. (The U. S. 120-mm. heavy-gun M103 tank now undergoing field tests, weighs 62½ tons to the T-54's reported 40 tons.)

SIGNIFICANTLY, Hungarian freedom fighters found the T-54's far less easy to set afire with Molotov cocktails and the like than the old T-34's. This quality appears to be an important asset in tactical atomic war, since ignition of inflammable materials by intense heat flash is an obvious and serious danger to armored vehicles and their crews.

The 100-mm. gun may also be significant for atomic warfare. A junior-grade atomic shell probably can be made in 100-mm. caliber before it can in the 90-mm. caliber of the U. S. Patton



Russia's new breech-loading 280-mm. mortar, credited with atomic capability. Towed on a two-wheeled bogie with base plate attached, it is air-transportable.

series tanks. In the meantime, the Soviets have a medium-weight tank with a heavy gun capable of firing a shell with high-explosive fragmentation and blast effect in the class of the standard U. S. light field artillery caliber (105-mm.).

The Soviets certainly have simplified their army weapons system by introducing a whole new "family" of infantry weapons. Included are a new pistol, submachine gun (replacement for the famous "burp" gun), and light machine gun. The last three, which are weapons of the infantry rifle squad, all use the same cartridge: a goal of the U. S. Army for infantry arms since World War II. The result is a great simplification of ammunition supply and production.

The cartridge is smaller and lighter than the new NATO light cartridge. The weapons themselves are lighter, too. Thus the Reds have achieved another of the U. S. Army's goals—getting the load off the back of the GI. Lightening the weapons and ammunition is also vitally important in making armies air transportable.

To do all this the Reds have made some sacrifices. Their new cartridge is less powerful than the proposed U. S.-NATO round and the current U. S. .30'06. Hence their rifle (a short one they correctly call a "carbine") and their machine gun have less range than older arms. However the new cartridge affords the new "burp" gun greater range, and it provides all three weapons with greater accuracy than their predecessors.

This firepower is supplemented by a new 9-mm. pistol. Like the old Mausers the Chinese police used to cherish, it has a 20-shot magazine and wooden combination shoulder stock-holster facilitating its use as a short-range full-automatic weapon by heavy weapons crews, service troops, and the like.

There are cogent reasons why the Soviets have built up infantry firepower while in most cases accepting reduced range. For one thing, their tacticians have concluded from their World War II experience that few men can engage targets beyond 400 meters (440 yards) accurately. For another, range still means power, which in turn requires sufficient weight of weapon to ensure safety as well as reliable functioning.

Finally, the Soviets have claimed that air power and mass destruction weapons will make fighting under cover of darkness a "must." In such conditions Soviet military thinkers don't hold accuracy and range to be as vital as volume of fire for shock effect and for the lightness which mobility and resupply demand.

As yet we can't say just how right the Soviets are nor how good their new "small-arms family" is. However we shall soon have a solid word on another new weapon—their 82-mm. recoilless rifle. This is already on the "give-away" list. Nasser's Egyptian Army got some, which the Israelis captured along with their ammunition.

Revealed on Aviation Day 1954, the big, tandem twin-rotor, twin-engined Yak-25 troop-carrying helicopter impressed Western observers (Sovfoto).

WHILE the open-topped 6-wheeled armored personnel carriers unveiled in 1951 have in recent years come into general use, and are now supplemented by a similar 4-wheeled armored weapons carrier, an amphibious and better-protected tracked carrier has shown up in the East German forces. Budapest street fighting showed that the earlier wheeled 9½-ton BTR-8 "transporters," while better than "soft" trucks, leave something to be desired even for conventional warfare and police action.

To date the BTR-8's, which are in many respects 6-wheeled close copies of the World War II U. S. 4-wheeled M3 scout car, have doubled as reconnaissance vehicles. Whether a newly displayed amphibious tank will serve the purpose better will be a moot point until combat renders a verdict. The Soviets have been fascinated with such

vehicles in the past, but World War II showed thin-skinned armor of the amphibious class seldom met reconnaissance requirements. The Soviets gave the type up late in 1941, but it's not safe to sneer without sure knowledge as to whether they may now have found a good solution.

The only new armored self-propelled artillery the Soviet Army has flaunted is in the antitank class. Last May Day the Moscow parade revealed a high-velocity cannon mounted on a tracked chassis with open-topped fighting compartment, both lightly armored. It appeared with paratroops and bore their insignia, so it appears to be the Soviet counterpart of the U. S. unarmored 90-mm. Spat.

However the Soviets have shown off a remarkable line of new towed artillery pieces, along with new fast tracked tractors to tow them. All too evidently the Soviets agree with U. S. Army Ordnance engineer N. S. Glassman (ORDNANCE, January-February 1956) that towed artillery is far from dead.

This new artillery has been very much simplified and lightened up. Obviously it is much more air-transportable than the older models. Characteristic are a marked reduction in the size of the recoil mechanisms and late-model muzzle brakes to reduce recoil. By improving ammunition, a light 152-mm. howitzer does the same job at about the same ranges as the ponderous M-1937 152-mm. gun-howitzer (the common World War II firepower tool, powerful but prone to bog down).

The new piece has a conventional split-trail carriage, but it is furnished with a disk-plate firing jack, rollers for the trails, and a spade that would appear to facilitate wide shifts of traverse in the manner of the British World War II 25-pounder. The trail bogie has been dispensed with, and the piece limbers right to its prime mover—usually a tractor with high cross-country capability.

The 152 "how" and the improved 122-mm. gun both travel on single- instead of dual-tired carriages. The new 122-mm. gun has ten per cent greater range, and like the 152 "how" dispenses with the huge balancing equilibrators once a prime characteristic of Soviet long-range medium artillery pieces.

In the May Day Moscow Parade of 1955, foreign military attachés goggled at the sight of some new 203-mm. gun-howitzers. U. S. Army authorities say these have atomic capability. They are much lighter and more mobile than their predecessors and have fifty per cent greater range.

More unusual is a huge mortar of the U. S. infantry-type, reported to be 240-mm. Towed on a 2-wheel bogie with large baseplate permanently attached, it, too, is credited with atomic capability (the first U. S. atomic shell was 280-mm.) It supplements an earlier 160-mm., which in turn succeeded the M-1938 and M-1943 120-mm. used in World War II and Korea and in the class of the current U. S. 4.2-inch (107-mm.).

It's a cheap and very air-transportable air-droppable atomic weapon. With plenty of punch with ordinary high explosive, it is breech- instead of muzzle-loading and has long range.

In antiaircraft, the new Soviet "family" of weapons includes a double- and quadruple-mounted superheavy machine gun (reported as 14.5-mm. or caliber .59). This replaces the M-1938 DShK single-barreled caliber .50 and is reminiscent of the Rheinmetall 20-mm. Flakzwillings and -vierlings. Replacing the Soviet 37-mm. M-1939 version of the Swedish Bofors (like the 40-mm. still used in the U. S. on the 1953 model M42 "flakwagon") is an automatic 57-mm. cannon. It has double the fire rate of the 37, and radar fire control. It has what seems to be a very light carriage.

THE 100-mm. heavy antiaircraft gun, evidently created in anticipation of the U. S. Air Force introduction of the B-36 bomber and used in 1953 for urban and industrial area defense, is now in service protecting the field forces. It is supplemented by a new and still heavier gun of 122-mm. caliber. Both have radar fire control. What these could do with atomic shells, even against high- and fast-flying jets and winged guided missiles, can well be imagined.

The existence of such powerful flak is no accident. In briefings to their own armed forces, the Soviets don't regard guns and shells as "old" while calling nuclear weapons and guided missiles "new." All are regarded as elements of a modern offensive and defensive weapons system. Thus in February 1956, Soviet Defense Minister

The new T-54 medium-weight tank carries a 100-mm. gun capable of firing light field-artillery high-explosive shells.

Marshal Zhukohov, told his armed forces:

"At present, antiaircraft defense is supplied with modern supersonic fighter planes, with high-quality antiaircraft artillery, antiaircraft rockets weapons, and other means of securing antiaircraft defense."

Neglected in the 1953 ORDNANCE article warnings was a very important class of matériel: army-type aviation and airlift. This omission was very serious. Subsequent Soviet revelations as to their progress in this line of hardware, and their capability for still further advances, have very much increased the significance of the new-type army arms.

Patently, such aviation vastly enhances the strategic and tactical mobility of the units armed with the new weapons and provides vital means of logistical support fit for modern warfare of all types and degrees of intensity.

Back in 1953 not much was thought about Soviet helicopters. Although three of the four principal current types had been revealed by then, they seemed fairly unimaginative adaptations of accepted British and American models. But, on Aviation Day in 1954, the huge Yak-25 was exhibited, and the West began to sit up and take notice. With it the Soviets had managed to do, and quickly, what others found a difficult problem: make a big tandem twin-rotor, twin-engined "chopper" work.

Later, when Westerners were able to get a closer look at older models, both within Russia and in Antarctica, estimates of Soviet helicopter achievement were drastically revised.

JOHN Fricker, an engineering correspondent of the British magazine, *Aeroplane,* and a pilot who has flown both Western and Soviet helicopters, reports the Soviet ships represent "highly practical designs covering light, medium, and heavy rotocraft operations in a unique fashion." He says from firsthand knowledge that the development of Soviet helicopters "took place in a remarkably short time and is additionally noteworthy for the quality of the machines involved."

He maintains that "the Russians have succeeded in getting more helicopters into civil and military service than any country, including the United States." Gen. Paul Geradot, former chief of the French Air Staff, goes along with Mr. Fricker, warning that the Soviets hold a considerable lead over the U. S. in helicopters.

What was quite unexpected in 1953 was the sort of jet transport that suddenly winged out of leaden London skies to land Soviet secret police Gen. Ivan A. Serov at Heathrow Airport in March 1956. What impressed U. S. and British observers most was its suitability to army airborne operations. The technical press noted: "As it descended into the circuit, it flew noticeably slowly, and approached, with Fowler flaps extended, at a most innocuous speed. The touchdown speed and landing run of the Tu-104 is low." So is the take-off run.

This capability contrasts with that of U. S. civil and military jet transports which land "hot" and require longer runways for landing and take-off by some thousands of yards than do their piston-powered predecessors.

The Tu-104's ability to fly and handle beautifully at low speeds is additionally advantageous because it permits parachuting of troops and cargo. Those who have examined civil Tu-104's have noted obvious provision for drop hatches, and the nose houses the same military navigational and bombing radar as the Badger bomber equivalent.

The Tu-104 is already flying Iron Curtain airlines and was operational months before the first production model of a U. S. counterpart took the air. The latter, the Boeing KC-135, will be in very short supply even for its main mission of refueling B-52 bombers of the Strategic Air Command, and last spring its production rate was scheduled for reduction from twenty to fifteen a month by next year. Hence it won't be available for U. S. Army airlift. The U. S.-built civil jets, deliveries of which won't start until 1959, are not yet adapted to army-type operations.

Before these appear, the Soviets are scheduled to have in service their 180-passenger civil transport version of the huge Bison, their equivalent of the U. S. B-52 jet bomber. Also scheduled is a transport version of the Bear turboprop bomber, which first flew in 1955. Like the 180-passenger jet, it's expected to enter service in 1958.

Exhibited in June 1956 was a smaller military turboprop transport, in the class with the present U. S. piston-engined Fairchild C-123. Its scaled-up civil version, Antonov's An-10 Ukrania, flew early in 1957 and can carry 84 passengers plus 3½ tons of cargo at 375 miles an hour cruising speed. It's in a class with the British Viscount. Since the Viscount and the much bigger USAF Lockheed C-130 turboprops are now in service, the Soviets trail in turboprops, although not as much as the U. S. trails the Soviets in pure jet transports.

SINCE the U. S. is hardly in the conventional-weapons contest at all any more, the best index to the Soviet potential for weaponeering advances is aircraft. In the 1953 ORDNANCE article, warnings concerning the future in all fields of military matériels used the MIG-15 jet fighter as an example of Soviet capability. The advent of the MIG-15 jet fighter in 1949-1951 had given the West a nasty surprise. Of recent years this example has been repeated and the warnings of 1953 reconfirmed.

The MIG-15's supersonic successor, the MIG-17, went into service in East Germany early in 1954. The new German Air Force holds it comparable to the F-100 Super Sabre, the first USAF squadron of which was formed late in 1954. (The MIG-17 last year was put on the Soviet "give-away" list; scores took part in the Cairo parade which Egypt's Nasser this year gave to impress Saudi Arabian and Syrian rulers.)

NOW the MIG-17 is being replaced by the still faster and better MIG-21 which made its public bow in 1956. As for all-weather high-performance fighters, the Yak-25 was flying in large numbers by July 1955. The comparable U. S. F-102 entered squadron service in May 1956.

That the Soviets rocked American complacency (why do we keep sinking back into it?) with the 1954 "Moscow

overflights" of the jet bombers Bison and Badger is now well known. At first wishful thinkers tried to make out that the Bison was a phoney to fool U. S. and foreign attachés. Developments in the next year disabused the most skeptical.

Not only did it become clear that the Soviets had gotten its huge jet bomber into service before the U. S. B-52, but in 1956 Gen. Earle E. Partridge, then Chief of the U. S. Air Defense Command, told Congress officially what aviation experts well knew. He testified that the unexpectedly sudden advent of the powerful jet Bison and Badger, and also the turboprop Bear bomber, had taken the U. S. by surprise and revealed it unprepared. The Soviet bombers were able to fly higher than the U. S. all-weather fighters then standard—the F-89, F-104, and F-86.

AS a final fillip, it is worth noting that among the prototype planes shown U. S. and British Air Force authorities at Russia's Kubinko Field in June 1956, but which were then unready to fly, was one said to be an armored airplane for close support of armies. Early in 1957 it was seen in service in numbers in Soviet squadrons stationed in East Germany.

The sad story, therefore, is that despite all the evidence available in 1953, and all the past lessons concerning the American tendency to underestimate the speed with which the Soviets make arms strides and the scale on which they make them, from 1954 on the Soviets again and again, in both air and army conventional-weapons fields, have outpaced and outproduced the U. S.

This we know. We also have an idea of Soviet progress in nuclear weaponeering, since their detected tests amount to some forty, as against nine for the British and over seventy for the U. S.

All this has grave significance. It points up the fact that the Soviets don't go along with Western talk about not being able to afford all types of weapons, conventional as well as "new." Very definitely the Soviets have been matching, in 1954-1955-1956, the debut of new aircraft (of which Americans have made much), with the debut of new army-type arms (which America has ignored), as well as with the development of nuclear and thermonuclear weapons (which the whole world knows about).

What about guided missiles? *The Soviets have boasted aplenty about their lead in long-range rocketry, but outsiders have yet to be shown a single Soviet missile!* Aircraft and conventional weapons have been shown galore, but nary a "bird."

What does this mean? Can we conclude that the Soviets have made as much progress in missiles as in aircraft and conventional weapons? Or are they (like the West) plagued with missile teething troubles, and hence fear to let any one see what they've got?

It also could be that the Soviets are doing just the opposite of Britain and America. They could be stressing aircraft and conventional weapons and waiting for missilery to mature. Meanwhile they can exploit America's propaganda about "new" weapons to their own international power politics advantage. They can, with mere words, affect an America and a free world already alarmed by American talk of missile power and potentials.

It seems clear that the only thing we can conclude with any sureness is that the Soviets will continue to progress in conventional weapons and aircraft. We have reason to fear, too, that their pace of progress will accelerate, for the Soviets seem to recognize that research and development constitute an art, and they will try to master and improve it.

What they have shown of conventional arms to date as yet represents no break-throughs, yet such are coming due in all classes. In land locomotion, for instance, U. S. Army Ordnance has taken a bold stand by releasing all information on the growth of the new science it has sponsored—terradynamics.

It has done so since 1955 on the correct assumption that open discussion and the free interchange of information is the best road to progress. But if U. S. defense authorities don't exploit the military potentials of this science, the Soviets will.

AS a result, if the defense of the free world is to be adequate, America must do not what she wants to do but what she has to do to stay safely ahead of the Soviet bloc.

The latter point is an important one: by integrating conventional army-type weapons with what we call "new" weapons and introducing new models of the "old" along with new models of the "new," the Soviets show that they have a very different idea of the theory and practice of warfare from those favored in Britain and America today.

To further the ends of military Communism, the Soviets seek neither arms simplification nor the risks involved by military policies governed by desire for economy rather than by hard military necessity.

Surely the preservation of the already dearly bought freedoms and wealth of Western civilization demands no less an effort than the one the Communists are making to destroy it.

The new 122-mm. long-range medium artillery weapon travels on a single-tired carriage without the old cumbersome balancing equilibrators (Sovfoto).

"Gain" Rifling

A number of old revolvers have been found with this type of rifling in which there is little or no angle of twist at the breech but a gradual increase of twist toward the muzzle to avoid bullet slippage

J. H. Mathews

IN the course of a study of rifling characteristics, in which over 2,000 handguns (revolvers, pistols, and automatics) have been measured, a number of revolvers have been found that have "gain" rifling, *i.e.*, the rate of turn increases from breech to muzzle.

Although such rifling has been known for a long time, it does not appear to have been used in handguns except for a few models of fairly early Colts and Remingtons. Its use was soon given up, but there are in existence today, in museums and in private collections, many guns having this type of rifling.

The main purpose of the investigations being made on rifling characteristics is to accumulate information which may be of value in law enforcement—information which will be useful in determining the "make" of gun which fired an evidence bullet. Special equipment and techniques have been designed and worked out for making the necessary measurements. The important measurements are: (1) bore or caliber, (2) direction of rifling twist, (3) pitch or rate of turn of the rifling (usually designated as inches of barrel required for one complete turn), (4) number of lands and grooves, (5) width of lands and grooves, and (6) the depth of the grooves.

The guns that have gain rifling are of the percussion type, though some of them have been converted to rim fire or center fire. Percussion-type guns are not likely to be used by the criminal today because it is so much easier to use cartridges. However these older guns do have interest for the collector or specialist.

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The guns were, for the most part, obtained from the Rosebush Collection in the museum of the Wisconsin State Historical Society at Madison, Wis. A few came from the Nunnemacher Collection in the Milwaukee Public Museum and some from private collectors. Many of the guns examined had rifling which was too corroded to allow reliable measurements to be made.

Since the present paper is concerned only with the twist of the rifling, descriptions of the apparatus and techniques used in making other measurements are being omitted, but a description of the method of measuring the twist of pitch of the rifling is deemed necessary.

The twist of the rifling is measured by means of the "Rifling Meter"—an instrument designed and built at the University of Wisconsin and described elsewhere (*Jour. Crim. Law and Criminology, Including the Amer. Jour. Police Science*, Vol. 35, p. 134, 1944).

In using this instrument, a lead disk about 1/16-inch thick and of suitable size (slightly larger than the bore), is forced through the barrel to be measured (by turning the handle which is at the right—see Figure 7) and readings of angular rotation of the disk (which follows the rifling) are made at equally spaced intervals—the length of interval depending on the length of the barrel and upon whether the barrel has gain rifling or not. The disk is mounted on the end of a "thrust rod" which in turn is held in the center (or hub) of the graduated circle which is mounted on ball bearings so that friction is reduced practically to zero.

THE disk is held on the end of the rod by tiny steel pins which center it and prevent it from slipping, and the rod is held firmly in the "hub" of the graduated disk by a setscrew. A vernier alongside the graduated circle enables one to read angles to 0.05-degree.

One half of the circle is graduated to the right, the other to the left, since guns may have either right-hand or left-hand twist in rifling. The lead disks are cut with a special punch and die set.

The amount of thrust is measured on the drum shown at the right end of the instrument below the reading lens (See Figure 7). This drum has 100 graduations, each representing 0.001-inch, so one revolution represents a forward movement of exactly 0.1-inch.

The screw has been calibrated and found to be accurate to plus or minus 0.001-inch over a distance of 6 inches. For a very short barrel, readings of rotation would be taken every 0.1- or 0.2-inch, while for longer barrels the readings might be taken at 0.5- or even 1.0-inch intervals if the rifling is uniform and in good condition.

In the case of gain rifling it has been found desirable to make measurements at short intervals—usually 0.2-inch, and to plot the successive readings of rotation against the length of barrel traversed. Measurements can be made from either end (if the barrel can be removed) and wherever possible they were made from *both* ends. If the two plots coincide where they overlap it serves as a good check on the accuracy of the measurements.

INASMUCH as the rifling is more likely to have defects near the ends of the barrel, the readings right at the end may be in slight error, and an extrapolation of the curve gives a more accurate result. In a number of cases it was found desirable to use the extrapolated value—as indicated in the accompanying plots of data opposite. In a few cases the condition of the barrel, at one end or the other, necessitated more extrapolation than is desired, but the error probably is not great. In the case of guns having barrels longer than the thrust rod, measurements were made from each end, wherever possible, and the two plots combined in case they overlapped in the center section.

The accuracy of flight of a fired bullet depends to a considerable degree on its velocity, rate of spin, shape, and the perfection of that shape. If anything happens to deform the bullet or to make it at all imperfect in shape its flight will not be true.

When a cartridge is fired in a revolver the bullet jumps forward and acquires a very considerable velocity before it encounters the rifling which, presenting a curved surface, produces a change in direction. When the bullet strikes the rifling it has to follow the curve of the lands of the rifling because it fits closely. But because of its high velocity at the moment of impact it resists changing its direction, and there

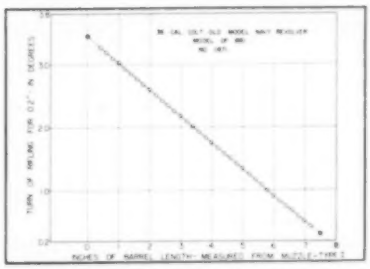
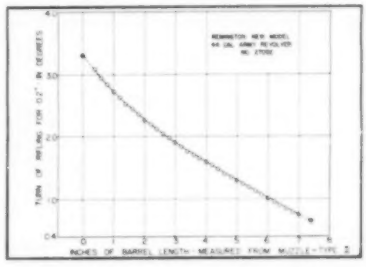
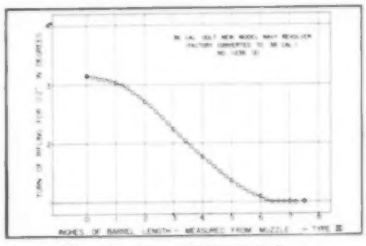


Fig. 1, above. Fig. 2, below





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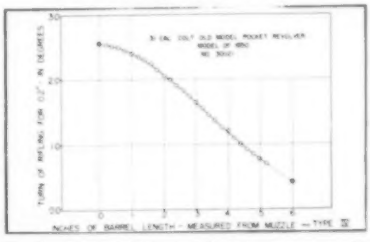


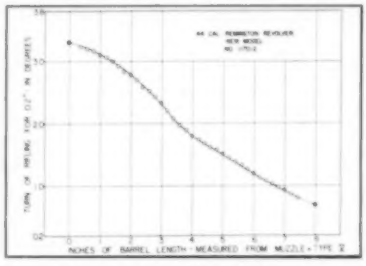
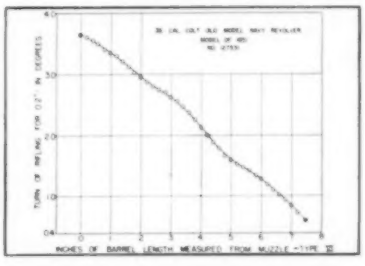


Fig. 5, above. Fig. 6, below



is always a tendency for the bullet to slip before it settles down to follow the rifling.

The result is that when lead bullets are fired from a revolver they almost invariably show "skid marks" due to this slippage. Jacketed bullets also show it very frequently, but naturally the slippage is not so marked. This slippage produces a surface that is not perfectly symmetrical, as it should be for perfect flight of the bullet.

In a rifle or in an automatic pistol, on the other hand, we have a different situation since in guns of these types the forward end of the bullet is practically in contact with the beginning of the rifling and engages the rifling before it has acquired much velocity and momentum.

The purpose of gain rifling, in which there is little or no angle of twist of the rifling at the breech but rather a gradual increase in angle of twist toward the muzzle, is to help the bullet to follow the rifling without slippage, as there is no sudden change in its direction after it has acquired considerable velocity.

The theory seems to be sound, and gain rifling was used in some of the revolvers made around the middle of the last century, but it was given up after a few years, perhaps because it was not easy to do a good job of rifling of this kind.

There seems to be a great deal of variation from gun to gun and little standardization. Also the shape of the plots of data (Figs. 1-6) indicates that there often was not a uniform change in the rifling pitch from breech to muzzle, as one would naturally expect. Furthermore, it was quite evident during the measurements that the rifling does not seem to be as perfect as in contemporary guns which do not have the gain rifling.

AT any rate, this method of rifling did not survive, and in the course of measurement of 2,000 guns from 23 countries no modern guns were found to have this type of rifling. Gain rifling, therefore (as far as handguns are concerned), is only of historic interest and is not very likely to be encountered in criminal investigations—although the

DATA FOR REVOLVERS HAVING "GAIN" RIFLING

Cal.	*Make*	*Model*	*Serial No.*	*Barrel Length (in.)*	*Dir'n. of Twist*	*Inches for one turn at breech*	*Inches for one turn at muzzle*	*No. of lands*	*Avg. Width of land (in.)*	*Bore Diam. (in.)*	*"Groove Diam." (in.)*	*Type of Rifling*
.28	Colt	Root Pat. Side Hammer	5377	3.5	L	85	21.8	7	0.050	0.2576	0.2663	II
.31	Colt	Old Pocket Mod. 1849	230871	4.0	L	∞	41.1	7	0.061	0.3083	0.3167	I
.31	Colt	Old Pocket Mod. 1849	241072	4.0	L	ca. 240	38.9	7	0.061	0.3070	0.3151	III
.31	Colt	Old Pocket Mod. 1850	141184	6.0	R	55.5	20.0	7	0.060	0.3070	0.3170	II
.31	Colt	Old Pocket Mod. 1850	194967	6.0	L	∞	26.2	7	0.065	0.3112	0.3169	I
.31	Colt	Old Pocket Mod. 1850	197108	6.0	L	ca. 240	27.2	7	0.058	0.3095	0.3193	I
.31	Colt	Old Pocket Mod. 1850	203885	6.0	L	∞	26.7	7	0.061	0.3097	0.3182	I
.31	Colt	Old Pocket Mod. 1850	250855	6.0	L	∞	36.0	7	0.062	0.3117	0.3176	I or IV
.31	Colt	Old Pocket Mod. 1850	301121	6.0	L	ca. 180	28.2	7	0.069	0.3141	0.3229	IV
.36	Colt	New Mod. Pocket	3459	4.5	L	90	30.0	7	0.090	0.3713	0.3795	I
.36	Colt	New Mod. Police 1862	9878	5.5	L	ca. 180	29.4	7	0.067	0.3723	0.3806	I
.36	Colt	New Mod. Police 1862	39351	5.0	L	90	29.8	7	0.082	0.3706	0.3824	I
.36	Colt	Old Mod. Navy 1851	7211	7.5	R	> 360	18.5	7	0.076	0.3698	0.3801	I
.36	Colt	Old Mod. Navy 1851	8258	7.5	R	> 360	18.0	7	0.075	0.3605	0.3715	I
.36	Colt	Old Mod. Navy 1851	9288	7.5	R	ca. 110	21.2	7	0.071	0.3615	0.3733	I
.36	Colt	Old Mod. Navy 1851	11871	7.5	R	ca. 240	20.9	7	0.075	0.3599	0.3714	I
.36	Colt	Old Mod. Navy 1851	113540	7.5	L	ca. 300	19.5	7	0.083	0.3700	0.3808	I
.36	Colt	Old Mod. Navy 1851	127531	7.5	L	ca. 120	19.7	7	0.071	0.3704	0.3814	VI
.36	Colt	New Mod. Navy 1861	7283	7.5	L	> 360	21.2	7	0.070	0.3671	0.3800	I
.38	Colt	New Mod. Navy Conversion	11236(2)	7.5	L	72	22.9	7	0.072	0.3743	0.3850	III
.38	Colt	New Mod. Pocket Conversion	306773	3.5	L	72	18.7	7	0.097	0.3707	0.3790	I
.44	Colt	Dragoon No. 2	13580	7.5	R	ca. 240	19.5	7	0.097			I
.44	Colt	Dragoon No. 3	19247	7.5	R		19.2	7	0.100	0.4438	0.4506	I
.44	Colt	New Mod. Army 1860	8951	8.0	R	> 360	20.9	7	0.077	0.4425	0.4541	I
.44	Colt	New Mod. Army 1860	37503	7-7/8	L	ca. 140	18.0	7	0.092	0.4360	0.4514	I
.44	Colt	New Mod. Army 1860	111473	8.0	R	> 360	19.5	7	0.089	0.4411	0.4505	I
.44	Colt	New Mod. Army 1860	131557	8.0	L	ca. 240	19.0	7	0.081	0.4412	0.4508	I
.44	Colt	New Mod. Army 1860	158793	8.0	L	> 360	18.5	7	0.099	0.4437		IV
.31	Remington	New Model Pocket	1033	3.0	L	34.3	19.5	5	0.095	0.3107	0.3172	I or II
.36	Remington	New Model Belt	27092	7.5	L	ca. 110	21.8	5	0.100	0.3600	0.3650	II
.44	Remington	New Model Army	101118	8.0	L	ca. 120	21.2	5	0.130	0.4380	0.4481	I
.44	Remington	New Model Army	115319	8.0	L	ca. 110	21.8	5	0.126	0.4360		IV
.44	Remington	New Model Army	117012	8.0	L	ca. 103	21.8	5	0.119	0.4382	0.4510	V
.31	E. Whitney	Officers' Model	8484	6.0	R	ca. 200	40.9	7	0.065	0.3100	0.3235	I

NOTE: For guns having an odd number of grooves the difference between the bore diameter and the "groove diameter" represents the depth of the groove. For guns having an even number of grooves one half of the difference represents the depth of the groove.

possibility exists for many early Colts and Remingtons have been converted to take rim-fire or center-fire cartridges.

As already has been remarked, the idea of gain rifling has long been known, but little regarding it is to be found in the literature. It has been used principally in heavy ordnance where it has been shown to be of considerable advantage in reducing the wear on the rifling, thus increasing the life of the barrels. In the case of a rifle barrel or any barrel of considerable length having a constant rifling pitch, the maximum wear occurs at the breech end of the barrel—say the first third of its length.

In this zone the temperature is highest and the gas pressures are greatest. If the rifling pitch is constant, as is the usual case, the rotational forces against the driving edges of the lands will be greatest in this region of high pressures, and consequently the wear of the lands will be the greatest in this area. Continual wear on the lands eventually will result in slippage of the bullet, and it will not reach the desired velocity nor the rotational spin necessary to produce stable flight.

Another point to be considered is the fact that bullets used in automatics (and many bullets for rifles) are jacketed with copper or an alloy which, being harder than lead, does not have as great a tendency to slip and to strip. Fouling is less, but the wear on the rifling will be greater because of the greater hardness of the bullet metal.

EXTENSIVE experiments have been made in Germany and in this country on various types of gain rifling in the case of machine-gun barrels and others where driving bands are used. While in such cases there may be a decided advantage in the use of gain or "progressive" rifling, it seems most unlikely that it can ever be shown to be of any advantage in the case of revolver barrels. The changing angle would produce a broadening of the grooves made by the lands on the bullet and would lead to inaccuracy and gas leakage.

The results of investigations on Colt and Remington revolvers seem to indicate that these manufacturers had some of the above-mentioned ideas about the possible advantages of gain rifling and did some experimenting along different lines.

"The purpose of gain rifling, in which there is little or no angle of twist of the rifling at the breech but rather a gradual increase in angle of twist toward the muzzle, is to help the bullet to follow the rifling without slippage."

BY making measurements of the rifling angle at intervals of 0.2-inch throughout the entire length of a barrel, data are obtained which make it possible to make graphs or plots which show the rate of change of the rifling angle. This was done for all the barrels that were in sufficiently good condition to measure, and it was found that the plots fell into six general types, as shown in the graphs on the preceding page.

In Type I the rifling angle increases regularly from breech to muzzle. This was the type most often encountered.

In Type II the angle increases fairly regularly at first then more rapidly toward the muzzle.

In Type III the angle remains constant for a time, then increases at a regular rate for about two-thirds of the barrel length, then increases at a diminishing rate.

In Type IV the angle increases linearly for about two-thirds of the barrel length, then at a diminishing rate to the muzzle.

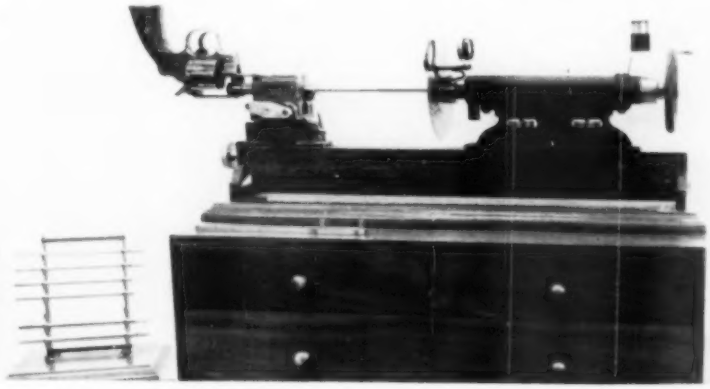
In Types V and VI we have plots that may be and probably are the results of mechanical difficulties. When these guns were made, about a hundred years ago, the art of rifling had not reached its present state of perfection. Inasmuch as no apparent useful purpose could be served by such rifling, it is presumed that the result achieved was unintentional. Our guess is that these barrels were intended to be rifled similarly to those of Type I.

The accompanying tabulations show the results of the measurements made, and the type of plot is indicated. While Type I predominates, it is believed that Types II, III, and IV also are intentional.

It seems from a study of these plots that the American manufacturers must have had in mind some of the considerations and claims found in the fairly recent German work. However, it is our guess that the principal concern was with the prevention of slippage due to the sudden encounter of the bullet with the rifling rather than with the question of prevention of wear on the lands. Our impression is that the first four types are definitely different experimental attempts to improve the ballistic performance of the gun. Whether they were based on sound theory or were just cut-and-try attempts one cannot know unless some records of the experimentation are found.

The use of gain rifling in the United States was of very short duration. Whether it was given up because of its ineffectiveness or because of the difficulties encountered in producing good rifling of this sort is not known, but one seems justified in concluding that both were contributing factors.

Fig. 7. Rifling meter measures the twist of the rifling.



New Army Vehicles

The T92 armored reconnaissance vehicle, above, is armed with a 76-mm. gun in a split turret and also caliber .30 and .50 machine guns.

Another view of the T92, above, shows its low silhouette and bogie arrangement. Weighing only 18 tons, it is designed for air transport.

Little David, above, is a remotely controlled mobile platform of many tactical uses. Larruping Lou, below, is a device for clearing mines.

The M102, above, gives armor protection to combat engineers. The towed device below automatically plants antitank mines. (All Army photos.)

Ballistic Missile of 1845

More than a hundred years ago a young Navy lieutenant devised an ingenious method of detonating a mortar shell using trailing wires and a galvanic battery, but lack of finances forced its abandonment

Robert L. Eichberg

ELECTRICALLY detonated ammunition is modern. So are ballistic missiles. So is the controllable air burst. But President James K. Polk, who died more than a hundred years ago, knew about them if he ever received a letter dated May 10, 1846, from Lieut. Henry Moor, U.S.N.

Lieutenant Moor's letter was marked "Confidential," but somehow a copy came into the hands of the editor of *Mechanics Magazine* of London, which published it in November 1846 with an editorial comment ending, "As we happen, however, to owe no allegiance to Mr. President Polk, we do not hesitate to make it public, for the benefit of our own and of all nations."

The letter is of considerable interest to those now engaged in ordnance work, especially electronic ordnance.

SINCE the speed of mortar shells, as timed by Lieutenant Moor more than 110 years ago, was only a little more than 100 feet a second, it was possible for a man with 0.25-second reaction time to control a manually functioned air burst within about 30 feet. Using a 1,500-foot pair of wires, a battery, a switch, and an electric detonator, Lieutenant Moor conducted several tests at Governors Island and Sandy Hook. He claimed to have scored five successful functions out of five launchings.

His determination to carry on the work in which he believed, despite apparent lack of interest on the part of the Government, makes his achievement most noteworthy. He wrote:

Mr. Eichberg is chief of the Technical Information Branch, Diamond Ordnance Fuze Laboratories, Washington, D. C.

"In reply to my letter of the 21st of August . . . it was stated that the Government could not afford the slightest assistance in carrying on my experiments. Feeling perfectly confident, however, that the success of my undertaking would give us a decided superiority in military and naval affairs, I determined to pursue it as far as my resources would permit."

But even more interesting is Lieutenant Moor's early concept of the advantages of proximity burst, air burst, and underwater burst, electrically controllable to occur when maximum damage might be inflicted upon the target, as compared with the conventional contact burst or fuze-timed burst of that period. Several selected extracts from his letter reveal his thinking. Lieutenant Moor's letter begins:

"Sir, I have the honor to inform you that in the month of May last, the happy idea occurred to me that a shell could be exploded during its flight by electricity, if it were fired with small wires attached to it of considerably greater length than the distance to which the shell was to be thrown; and thus the inner ends would not be disturbed by the motion of the shell, but would be free to be taken to a galvanic battery at any moment during its flight.

"I immediately saw that this application of electricity would be of more importance in military affairs than anything that had taken place since the invention of gunpowder, and commenced a correspondence with the Government . . ."

The letter then refers to the fruitless correspondence which culminated with the Government's denial of assistance. The experiments were pursued, however, and mention is made of a letter report describing results of a test conducted at Governors Island on December 31, 1845—a letter which apparently went unanswered.

Lieutenant Moor next describes experiments made at Sandy Hook on April 11, 1846, with a 5 2/3-inch mortar launching a 24-pound shot with a 1-ounce charge of powder.

"Two conducting wires of 1,500 feet each were made fast to the ring bolt on the shot, and being laid so as to run freely, a metallic communication was maintained between the shot and the point from which it was fired during the whole flight of the shot . . . A small cartridge was secured to the shot, and with this cartridge, the outer end of the wires communicated.

"This cartridge, containing a small explosive composition, on which elec-

tricity would act with perfect instantaneousness, would, in the case of a shell, have been placed inside of the powder of the shell, but having no shells to experiment with, it was secured in the above manner to the outside of the shot, and when placed in the mortar, laid on the forward part of the shot next to the muzzle.

"The first shot that was fired fell at the distance of 674 feet, and just previous to its fall, when it had reached about 500 feet from the mortar, the inner ends of the wires were brought to the battery, and at that very instant the cartridge on the shot exploded. The flash and smoke of the cartridge were distinctly visible, and after the shot fell, it was examined, and the contents of the cartridge found to be entirely consumed."

Four more shots were fired with equal results before the insulation on the wire became defective, and the series was discontinued. One additional shot was launched with a 2-ounce charge. It traveled 1,050 feet, carrying the control wire, which was still unbroken. The wire used by Lieutenant Moor was No. 26 copper, each conductor insulated, and a wrap around the pair; it weighed 4 pounds.

He adds, rather pathetically: "From some experiments I have made, I am inclined to think that very fine steel wire, as high as No. 36 or 40, and not weighing more than an ounce to the hundred feet, would answer equally well, but I am prevented from using it by the expense."

THE lieutenant devised an ingenious switch for his experiments.

"The perfect instantaneousness with which the explosion is effected is a matter of the highest importance, and this part of the experiment is the most satisfactory of all. I have succeeded in making the connection between the battery and the conducting wire through a percussion pistol, so that snapping the lock will bring the wire in communication with the battery. Now, a person one hundred feet from the spot, watching the flight of the shot, will observe the explosion of the cartridge before he hears the report of the pistol. This difference of time is so small that it can hardly be measured by any other means; it does not, in fact, exceed the tenth of a second.

"Another consideration of equal importance is the fact that the electric shell is projected with so moderate a velocity, that it is not lost sight of, but can be distinctly traced by the eye from the moment of its leaving the gun to the end of its flight."

Lieutenant Moor next tells of the advantages of air burst:

"The French, at the siege of Antwerp a few years ago, made use of a

24-inch shell carrying 150 pounds of powder. But this, like almost all other shells, was thrown away for want of some power to control it after it was discharged from the mortar. Had it been subjected to the command of electricity, it would, in its passage over a fortification, have entirely dismantled it, or swept down whole ranks in its passage over any force opposed to it; or if on the water, it would have destroyed an enemy's ship, set fire to the shipping in a harbor, and annihilated everything that was perishable at any point of its passage."

Not only air-burst but proximity-fuze action, too, was envisioned by Lieutenant Moor, who wrote:

"I wish particularly to call attention to the fact that it is not necessary for the electric shell, like other shot and shells, to strike the object in order to produce its effects; it is only necessary to pass over it or near it when the explosion is to be effected, and the enormous volume and intensity of the flame will destroy and set fire to everything in its vicinity . . . The explosion near the deck of a ship would instantly disable her and set her in a blaze; she could not without similar weapons, and defenses altogether different from any at present in use, maintain the contest for a moment."

The lieutenant then analyzes targets and makes some comparisons between his electric shell and the "torpedo"—the name then given to a moored underwater mine.

"I cannot too strongly insist on the fact that against the action of the electric shell there is no protection for those attacked. The ship has no bulwarks to prevent the effects of the explosion as it passes over her decks, and all fortifications are built with reference to the lateral attack only, while overhead a much greater space is left without the slightest protection.

"The explosion of shells over this great extent of exposure would immediately make any fortress untenable. This advantage is so great that it will give the nation which first make (*sic*) use of electric shells entire supremacy both on land and water, as all defenses, as at present constructed, would be laid open to its attacks.

"The torpedo has excited much attention in this country, and is no doubt very efficient in case the enemy comes directly over the spot where it is placed. But here we have the torpedo armed to fly over the deck of a ship, to attack the enemy on their own coast, destroy the shipping in their harbors, ascend their rivers and penetrate into the heart of their country, or to repel like attacks abroad.'

EVEN a hundred and ten years ago the economic factor was of prime importance, for Lieutenant Moor continues:

"Our military and naval forces will have a superiority over all others, which by the present armament could not be secured without the expenditure of hundreds of millions. Any harbor, however strong its defenses, would immediately be compelled to submit to terms.

"Our smallest merchant ships could easily carry a 12-inch mortar, which would be sufficient to destroy the largest ships afloat. As this consideration is of much importance at the present time, it will be well to state that this mortar, with 50 loaded shells, and the necessary fixtures, would not exceed an expense of $1,000, and as they could be cast in a very short time, our merchant ships could traverse the ocean with safety."

I do not know whether Lieutenant Moor was ever granted sufficient funds to buy his 3,000 feet of steel wire, but, at all events, a belated salute to farsighted Lieut. Henry Moor, U.S.N., who may be the father of electrically detonated ammunition.

Defense Highlights: Monthly Review and Outlook

• **Missiles vs. Missiles.**—Our private citizens, administrators, and legislators must be completely lost in a morass of missiles and money now that the experts have introduced antimissiles and anti-antimissiles. When money for such weapons development is requested several years before a simple intercontinental ballistic missile is ready for test or even before a mere intermediate-range missile passes the preprototype stage, it is evident that some long long-range planning is in progress.

In speaking for the need to develop antimissile missiles, Lieut. Gen. James M. Gavin, Chief of Army Research and Development, told a congressional committee that "defense against a surface-to-surface missile including the ICBM is entirely feasible." He deplored the cut in funds from $20 to $12 million for antimissile development.

At another hearing in Congress, Maj. Gen. B. W. Schriever, Chief of Air Force Missile Development, admitted that his office was studying an anti-antiballistic-missile missile to "defend" an ICBM missile. In addition, the Air Force has contracts in effect to prepare for development of an antimissile missile.

In connection with defense against enemy ballistic missiles, it is revealed now that Deputy Defense Secretary Donald A. Quarles, when Secretary of the Air Force, told Congress that equipment being developed could be added to our distant early warning net that would give about fifteen minutes' notice of approaching missiles. However, he noted that it would be extremely expensive to establish a complete antimissile defense system.

• **Important Personnel Changes.**—There are many important changes in top Defense Department positions. Assistant Secretary of Defense for Research and Engineering Frank D. Newbury has resigned and his deputy, W. M. Holaday, has been named Special Assistant to the Secretary of Defense for Guided Missiles to relieve Eger V. Murphree.

Lieut. Gen. T. S. Power will take over command of the Strategic Air Force in August, replacing Gen. Curtis E. LeMay, who has been appointed Vice Chief of Staff of the Air Force. Before his tour as Commander of the Air Research and Development Command, General Power was Vice Commander of SAC.

Two new Assistant Secretaries of the Navy have been appointed to fill vacancies: Fred A. Bantz (Material), formerly vice-president of J. C. Penney Company, and J. Sinclair Armstrong (Finance) formerly Chairman of the Securities and Exchange Commission.

Rear Adm. Robert E. Dixon, has been nominated Chief of the Navy Bureau of Aëronautics to relieve Rear Adm. J. S. Russell who goes to sea as Deputy Commander, Atlantic Fleet.

• **High-speed Alert.**—A new high-speed civil-defense communication net is in operation. It can flash an alert from the center in Colorado to 200 key points throughout the country in one minute. Formerly it took over eight minutes to alert all stations.

• **Setback for Manpower.**—Inducements to retain trained military personnel have suffered a setback in the extreme anxiety and political jockeying over the budget. Ralph J. Cordiner, president of General Electric Company, and his Government Advisory Committee on Professional and Technical Compensation were annoyed at the "half measures" extracted from their recommendations, based on study that took over a year. Their revolutionary proposal to base promotion on competence rather than longevity was ignored, and the Budget Bureau found the plan "not opportune."

The Defense Department gave some consideration to the Cordiner recommendations by increasing the pay of all enlisted technicians. However, Mr. Cordiner claimed present personnel practices wasteful since about eighty-seven per cent of the skilled technical men leave the services as soon as possible and few young pilots remain in service after their required time has expired. The committee claims that there would be an 8 to 16 per cent improvement in combat capabilities within 5 years which could be measured in savings at a rate of about $5 billion annually by 1962.

It is problematical if any more top industrial leaders will be quick to serve on study committees after they note what has happened to Mr. Cordiner's recommendations and two years ago to those of the Paul L. Davies Committee on Army reorganization.

•**Helicopter Assault Ship.**—The first helicopter assault ship to be built by the Navy for the Marine Corps will carry 20 helicopters, 2,000 men, and supporting supplies. It should join the fleet in 1961. For several years the Marines have been using a converted CVE to experiment with vertical-envelopment tactics. When enough assault ships and helicopters are available our Marines can eliminate the deadly beach landings which resulted in such heavy casualties in World War II.

• **Low-powered Atomic Seaplane.**—The Navy is reported to favor a low-powered seaplane for its first atomic-powered aircraft. Slower speed than the P6M's designed 600 knots would be acceptable in an initial nuclear-powered type, offset by a great increase in endurance for long overseas patrols.

• **Proprietary Rights.**—At last the Defense Department has clarified some of the fuzzy area in its handling of proprietary

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rights. Revision 21 of the Armed Services Procurement Regulations codifies past practices and adds some new restrictions including a requirement that the Government must negotiate for proprietary information it uses in a general contract proposal.

• **Spare Parts Economy.**—Spare parts supply costs have been cut almost in half by new Air Force policies. Material for large spares is set aside but not processed until sufficient operational experience is obtained. In the case of large airborne parts, only a small quantity is produced until an increased need is foreseen. A total of eighteen million dollars was saved last year by returning excess spares to the manufacturer for use in his current production line.

• **Europe Located at Last.**—Europe is now on the map! At least the Air Force has determined the exact location of that old continent by precise electronic navigation methods in a 4-year project. The basic data are classified secret—perhaps because it has also been discovered where North America is located. Seriously, this can be vital information as one can determine if he works out the error in fall of a ballistic missile that is released with an initial error of 5 seconds of arc for a 4,000-mile flight.

• **The Vanguard Program.**—The Navy announced its second test in the Vanguard satellite program in which the high-altitude separation of the third-stage rocket from the second stage was undertaken. No comment was made as to whether the separation velocities met requirements, but shortly thereafter it was announced that the first complete satellite firing of the program would not be ready until late 1958.

As part of the program to ensure maximum results from the Vanguard satellite the Navy continues to probe the atmosphere with its Aerobee-Hi research rocket. Recently a record-breaking height of 190 miles was achieved by an Aerobee-Hi launched from White Sands Proving Ground, N. Mex. The flight was programmed to get more data for solar battery developments and to report on impact and density of meteoric particles.

• **Blunt Nose for Missiles.**—The break-through made five years ago that proved a blunt nose cone was the optimum shape for supersonic reëntry of missiles into the atmosphere has just been revealed to the public. Dr. H. Julian Allen, Ames Aëronautical Laboratory, has been awarded the Distinguished Service Medal of the National Advisory Committee for Aëronautics for the discovery. Dr. Allen's studies broke the long-believed theory that a sharp nose was desirable and showed that a blunt nose greatly reduced the heat of reëntry. It is still a difficult problem but no longer almost insurmountable.

• **Advice on Survival.**—"Industry Planning for Continuity of Production in the Event of Enemy Attack" is issued by the Business and Defense Services Administration, Department of Commerce. These two large mouthfuls represent some excellent advice and wise guidance to all manufacturers. If this country is attacked, many plants will be demolished, many will survive, some will be partly damaged. But if they follow the wise precautions in this booklet they will be prepared to bounce back and produce like mad to make up for the lost production capacity that would be needed urgently.

• **Individual Helicopter.**—The day of strap-on personal mechanical wings is approaching fast. In a true spirit of unification the Navy's Office of Naval Research has been working with Rotor-Craft Corporation since 1950 to develop a "one-man" flying machine that appears ideal for a winged infantry company. The new device, called "Pinwheel," is in effect a tiny helicopter propelled by a liquid rocket motor at both wing tips. Pinwheel can carry an infantryman equipped with flame thrower or a 75-mm. recoilless rifle with a flight endurance to date of ten minutes.

• **Atomic Weapons.**—It was estimated by an informed authority that the United States has sufficient atomic materials to produce about 35,000 atomic weapons. This estimate fits in with a comment by Army Secretary Wilber M. Brucker that the cost of atomic firepower has declined so that it compares favorably with use of high-explosive weapons in many circumstances. The number of weapons required and the men to service and operate them are greatly reduced when matched with equal effectiveness of fire.

Secretary Brucker also noted that the general availability of nuclear weapons to this country and its allies and to Communists countries had resulted in a major over-all shift of emphasis to guided missiles with atomic capability due to their greater range.

• **Radar Patrol.**—With the Atlantic Ocean flank of the Distant Early Warning (DEW) line extended by the Navy's Atlantic Fleet Barrier Patrol, five radar picket ships have been sent to help cover the Pacific end. All five ships are 1,200-ton destroyer-escort types with special radar equipment for detecting aircraft and missiles.

• **Ordnance Education.**—The Ordnance School at Aberdeen Proving Ground is a time-honored institution. Its courses have been streamlined, its student body enlarged. Management of ordnance units and technical activities are accented. Here junior officers of Army Ordnance get their basic 10-week education.

After a 2- to 5-year assignment in the field the career officer will attend the very comprehensive Ordnance company officer course which is designed to qualify him further to serve as a company commander. Five years later he will return to the school to take the Advanced Course to prepare himself for service as a senior ordnance staff officer or commander. The faculty of the school is ideally equipped by training and experience to impart principles of wide application.

The enrollment in the school in May 1957 totaled 2,166 officers and enlisted men, including among the students 97 officers and men of allied armies.

The Armament Prospect

An Editorial

MOST sensible people stop from time to time to take their bearings. They survey what has gone before, they take a look at the present, and analyze the probabilities of the future. This is an appropriate time to take a look at the armament prospect before us.

With this issue, ORDNANCE magazine begins its forty-second volume. The current issue is the 223rd number published in the long unbroken series begun July 1, 1920. Each of these publications was replete with studies, reviews, plans, and programs for advancing armament preparedness in the United States.

Many other publications the world over devoted to particular purposes have adhered strictly to their chosen goals, but none has surpassed ORDNANCE in its continuous emphasis of its one and only purpose—to advance armament readiness in our country through scientific and industrial preparedness.

Tremendous changes have occurred during the period throughout which this magazine and the Association which publishes it have carried the banner of armament research, development, production, and maintenance. Many of the forms of weaponry which were predominant in 1920 have disappeared from the scene. Others are becoming obsolescent. Many newcomers within the past decade have burst upon the field with far-reaching implications on the military strategy and tactics of the future.

It is well that we stop for a moment to make certain that in this period of change and uncertainty the principles that underlie our armament philosophy are sound, proved, tenable—and keyed to the nuclear age.

IT is difficult to stress time-tried principles of armament, especially to those who have not lived through the cycles of supply and demand which are the results of war and all the shadowy interludes between war and peace. At times our weapons dominate the thinking of all our people. At other times, popular interest is subzero. Even among some of the military the prevailing attitude is reflected in the easygoing way in which ordnance is referred to as "hardware"—as though the inherent problems in its design, production, and use did not involve all the scientific and technical application extending over years of study and embodying countless hours of engineering skill and planning.

As we review the period since 1920, nothing has appeared to challenge the principles on which the Ordnance Association was founded and to which this magazine is devoted. Simply stated they are of the very essence of armament preparedness in the United States. They embrace:

1. Close support of the armed forces—Army, Navy, Air Force, and the Atomic Energy Commission—with all the know-how, facilities, and skills of American science and industry.

2. Acknowledgement of the uncontested mission of the services to determine the types of weapons they require to accomplish their assigned missions and to fix the requirements as to their quantitative needs.

3. A high degree of preparedness on the part of American industry to fulfill those requirements in quality and quantity adequate to the needs of the services and surpassing those of any prospective enemy.

This simple doctrine applies with full force and effect whether the weapons concerned be the hand arms of the fighting man with ranges calculated in feet, the field equipment of the combat team with ranges calculated in yards, or the self-propelled missile with ranges calculated in hundreds and even thousands of miles.

As to the weapons themselves at this stage of affairs, the record clearly indicates the need of maintaining a balance between the new and the old. There is a middle point of view between the proponent of the self-propelled projectile who sees in it the obliteration of all past forms of combat and the die-hard who insists that the tactics and equipment of close-order formation still hold their traditional place.

The fact is, as most sensible people contend, there is at this stage of our progress a place for both schools of thought and certainly a prospective use of all types of equipment depending upon the nature of the battle that must be fought.

Over and above the weapons themselves there is still the most essential element of trained personnel in factory and in battle upon whom the efficacy of armament preparedness finally rests. They must know the problem and know how to solve it with the tools at hand, whether they are in the uniform of the Army, the Navy, the Marines, or the Air Force, or in the work clothes of the plant.

Our armament team has always been noted for its training, its devotion, its loyalty, and its efficiency. These are the priceless ingredients of superior weapons regardless of their model and irrespective of the speed at which they travel.

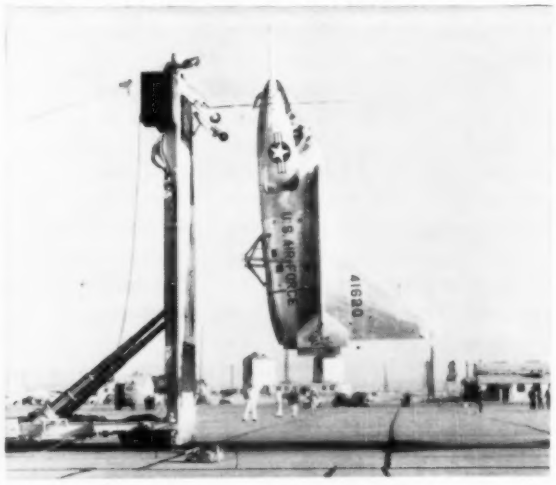
And underlying the entire philosophy is the problem of cost—cost in time, in lives, and in money. The pages of ORDNANCE in future as in the past must stress the necessity of keeping the cost of our armament down, of eliminating waste both in organization and in product, and of improving quality. These are considerations which are inherent in every successful business enterprise; they are equally essential in the business of the Nation's defense.

ALL this is in the best tradition of the Science-Industry-Ordnance Team. The principles remain unchanged while many of the weapons are changing completely. The present marks a transition period as some of the older forms gradually give way to the new. The armament prospect before us reveals no problems which our ingenuity cannot solve and no demands of time and effort of which we are not capable. That prospect, if the time-tried principles are adhered to, may bring some semblance of longer abiding periods of peace.

New Shapes in the Sky

The unusual-looking aircraft above is the first tilt-wing model ever built. Designated the Vertol 76, it was developed for the Army and the Office of Naval Research by the Vertol Aircraft Corporation. When the wing and rotor-propellers are tilted horizontally, left, it will fly like an airplane; when tilted vertically, right, it operates as a helicopter.

The Sikorsky H-37A twin-engined assault transport and cargo helicopter, above, is the Army's largest. It can carry 33 fully equipped soldiers compared with a limit of 20 in the largest craft now operational. Clamshell doors in the nose open to take on assault troops or cargo easily and to discharge them in short order in the combat zone (Army photos).



The Air Force X-13 Vertijet, above, a jet-powered vertical take-off and landing research airplane built by Ryan Aëronautical Company, is shown at left being raised to the vertical position on its ground service trailer. At right, it has unhooked from the trailer and is beginning to ascend, after which it turns to horizontal flight (Air Force photos).

ASSOCIATION AFFAIRS

Electronic Components Committee Holds Meeting at Huntsville, Ala.

Fifty-six A.O.A. members spent nearly two busy days at Redstone Arsenal, Huntsville, Ala., on March 6 and 7, 1957, attending a meeting of the Electronic Components Committee of the Electronics Division. The meeting included a day of discussions of problems encountered in the use of electric component parts in guided missile weapon systems. The problems were discussed by members of the Committee and by members of the staff of Redstone Arsenal, the Army Ballistic Missile Agency, and Ordnance corporation contractors.

On March 6th the visitors were cordially welcomed to Redstone Arsenal by Brig. Gen. J. G. Shinkle, deputy arsenal commander. In responding to this welcome, Brig. Gen. Burton O. Lewis, U. S. Army (Ret.), A.O.A. staff consultant for Technical Divisions and Committees, outlined the purpose and objectives of A.O.A. and the Electronic Components Committee.

Paul S. Darnell, Bell Telephone Laboratories, Whippany, N. J., chairman of the Committee, led the discussion assisted by four members of the projects management staff, Research and Development Division, Redstone Arsenal: Gregory S. Moshkoff, Robert C. Haraway, Earl L. Bible, and Charles W. Parker.

As background for the discussion period, Col. M. B. Chatfield, chief of the Research and Development Division, Ordnance Missile Laboratories, Redstone Arsenal, presented general problems encountered in the development of guided-missile weapon systems. These problems included the effects of telescoped programs and the unavailability of "in-flight" environmental data.

Maj. William S. O'Connor, chief of the Maintenance Branch, Field Service Division, presented the Ordnance maintenance philosophy as it applies to guided missiles.

The following specific problems were then presented and discussed by all attending: (1) How to get good electrical connections; (2) The miniaturization challenge to the packaging engineer; (3) Uncaging and position pick-off problems with a nonelectric gyroscope; (4) Have requirements placed on gyroscopes exceeded the state of the art? (5) Problems encountered in the design of a stabilized platform servo system; (6) The need for better, more stable RF components in the Ka band region; (7) Deficiencies in military specifications; (8) Problems encountered in the use of deposited carbon resistors, miniature connectors, cam-actuated switches, and precision potentiometers; (9) The approach being taken to establish a manufacturing facility for making high-reliability deposited-carbon resistors.

The problems were presented by Jewel W. Moody, Army Ballistic Missile Agency; Mr. Bible; Peter C. Hand, Martin Company; John Owings, Gilfillan Brothers, Inc.; John Jagy, Ford Instrument Company; Louis B. Forman, Chrysler Corporation; John H. Hershey, Bell Telephone Laboratories; Daniel P. Welch, Cornell Aëronautical Laboratory; and Kenneth L. Womach, Western Electric Company.

At the dinner meeting held at the Officers' Club, Redstone Arsenal, March 6th, Robert Lusser, reliability coördinator, Redstone Arsenal, entertained the seventy-five A.O.A members and arsenal guests with a story of the development of the V-1 rocket in Germany during World War II.

The tour of the arsenal facilities on March 7th included stops at the following: (1) The Acceptance and Inspection Branch of the Industrial Division where the group was briefed on the new mechanical and electronic gage laboratory facilities and pilot-lot inspection facilities presently being completed; (2) The Army Ballistic Missile Agency test area where the large motor static testing facilities are located; (3) The Ordnance Guided Missile School where missile maintenance techniques are taught; and (4) The Rocket Development Laboratory test range where the static firing of a large rocket motor was witnessed.

This meeting developed a number of problems on electronic components which will be considered at the fall meeting.

Attending Electronics Components Committee Meeting at Redstone Arsenal were, left to right: Henry Handler; Charles W. Parker; Paul S. Darnell, Committee chairman; Brig. Gen. Burton O. Lewis; Brig. Gen. J. G. Shinkle, deputy commanding general of Redstone Arsenal; Col. M. B. Chatfield; and Col. Samuel Smellow.

Michigan Post Sponsors Military Equipment Display on Armed Forces Day

The Michigan Post participated to the fullest extent in making Armed Forces Day in the Detroit area a great success. The big event was the sponsoring of the display of military equipment of all types that was assembled in the Detroit Arsenal. This project was in coöperation with Col. Herbert Wurtzler, commanding officer of the arsenal. Almost every company member in the Michigan Post that

is producing unclassified military equipment had an entry in the exhibit.

In addition, an impressive number of A.O.A. members devoted their time on the various committees that spearheaded the Detroit Eighth Annual Armed Forces Day preparations. Irving A. Duffy, member at large of the national Council, was general chairman. On the executive committee were Robert L. Biggers, vice-president of the A.O.A., and the finance chairman was Charles W. Brownell, secretary-treasurer of the Michigan Post.

The highlight of the week was an Armed Forces Day luncheon at which Adm. Jerauld Wright was guest of honor and principal speaker and Mr. Duffy was presiding officer.

Empire Post Inaugurates Officers, Awards Engineering Study Funds

The Empire Post has experienced its usual high degree of activity in recent months. On April 30th, at a directors' meeting at the Rochester Club, Rochester, N. Y., the incumbent and newly elected officers assembled to witness Ralph F. Peo, retiring Post president turn the gavel over to Claude G. Wright of Page Airways, Inc., who assumed leadership of Post affairs on that date.

Serving with Mr. Wright will be Vice-presidents John J. O'Neil, Cornell Aëronautical Laboratory, Buffalo, and John H. Bouman, Ansco Division, General Analine & Film Corporation; Col. William A. Davis, deputy chief, Rochester Ordnance District, Post secretary; Treasurer Raymond M. Biehler, Rochester Institute of Technology; and Lee W. Hiatt, Rochester Ordnance District, assistant secretary.

A notable and most worthy project was launched by the Empire Post at this meeting. Mr. O'Neil reported on the results of his study and discussions of the past month regarding the steps that could be taken to encourage further interest among students in an engineering education. Based on this report the directors voted that the Post should award $500 to each of five universities to be used in any manner they chose to encourage or improve engineering education. It was made clear that such a sum would not go very far in supporting a scholarship but could be used for such purposes as special field trips for students or faculty members, assisting students who need special help, and in general to encourage in every way an interest in the engineering and scientific disciplines.

The engineering departments of the following colleges will receive the awards: Syracuse University, Cornell University, University of Buffalo, Rochester Institute of Technology, and University of Rochester.

The Syracuse Chapter of the Empire Post was also in the limelight with a seminar and dinner meeting on Thursday, May 16th, at the Hotel Onondaga in Syracuse. In the afternoon at 4:30 Col. C. H. M. Roberts, director of defense of Pass & Seymour, Inc., led a panel of experts in a discussion on doing business with the Government.

The panel included Fred Gangberg of General Electric Company, Conan A. Priest of Onandaga Pottery's Electronics Division, Harold P. Martin of Carrier Corporation, and Charles S. Sliter of Pass & Seymour, Inc.

Also present to assist in clarifying doubtful points were the following representatives from the armed forces: Col. William A. Davis, Rochester Ordnance District; Col. Alexander S. Young, Rochester Air Force Procurement District; Comdr. John A. Taylor, naval inspector of material; Norbert J. Finkler, Small Business Administration.

It proved to be a most interesting and informative session with a lively discussion that helped to clear up many problems.

At the evening dinner meeting, George W. Auld, Chapter chairman was presiding officer.

Mr. Auld opened the meeting by calling on Arthur D. Stone of Stone Machinery Company to read the preamble to the A.O.A. constitution. The presiding officer then welcomed the members and guests and especially emphasized the significance of Armed Forces Week.

The highlight of the meeting preliminaries was the presentation of the check for $500 to the Syracuse University College of Engineering for the encouragement of engineering and scientific studies. It was accepted by Dr. Ralph S. Galbraith, dean of the college. The university was the first of the five which are to receive the scholarship award founded by the Empire Post.

Daniel H. Robinson of Precision Castings Company was introduced and highly praised by the presiding officer for his excellent arrangements for the meeting as program chairman.

Mr. Robinson then introduced the guest speaker, Ira G. Ross, executive vice-president and director of the Cornell Aëronautical Laboratory, Buffalo. Mr. Ross gave a most illuminating talk on "Technologic Growth Versus Inflation." He made particular mention of the danger of too much of our research efforts being diverted to improvement of products rather than the basic research on which new products must depend. He said that only in this manner can the United States hope to improve its standard of living and maintain its position of leadership in the world.

New Empire Post officers are, left to right: Lee W. Hiatt, assistant secretary; John H. Bouman, first vice-president; Claude G. Wright, president; John J. O'Neil, second vice-president; Col. William A. Davis, secretary; Gwyn Thomas, Council representative. Not shown on the photograph is Raymond M. Biehler, treasurer.

Puget Sound Post Honors Gen. Benjamin W. Chidlaw at Rainier Club, Seattle

The Puget Sound Post held a special meeting at the Rainier Club in Seattle, Wash., on Thursday, May 16th, to honor Gen. Benjamin W. Chidlaw, national A.O.A. president. Presiding Officer Col. Marmion D. Mills, Post president, also took the occasion to honor the following men who have assumed offices in the national A.O.A. organization: Regional

Vice-president Wellwood Beall, senior vice-president of Boeing Airplane Company; National Director Lysle Wood, general manager, Pilotless Aircraft Division, Boeing Airplane Company; Council Member Ernest Jones of Skagit Steel & Iron Works; Advisory Board Members Paul Pigott, president of Pacific Car & Foundry Company, and Fairman B. Lee, Post secretary-treasurer.

General Chidlaw spoke on the aims, operations, and problems of the A.O.A. He stressed particularly the duplication of activities of the professional divisions of the many societies and associations that serve industry and the armed forces in a technical capacity. The general asked his audience to discuss the problem and consider possible solutions to reduce the load on officers and engineers who must attend the many meetings of the various societies and associations.

Philadelphia Post Meets at Martin Company Plant and Honors Al Gilmer

The Philadelphia Post enjoyed the hospitality of the Martin Company at its Baltimore Plant on Wednesday May 15th.

Over 400 members entrained in Philadelphia and pulled into the main gate of the plant about 4:30 p.m. Other members drove in to swell the crowd to 480 for this unique celebration of the Post's thirtieth annual meeting.

An early dinner was served at one of the many large restaurants inside the

Albert W. Gilmer
Awarded John C. Jones Medal

plant after which the meeting was called to order by Post President Everett B. Webster who welcomed the members and guests and thanked the Martin Company for its generous cooperation. F. N. Nutt, director of public information, replied on behalf of the company and introduced Jess M. Sweetser, vice-president of sales, Martin Company, the host for this occasion.

Albert W. Gilmer, vice-chairman of the Post's nominating committee, presented the proposed slate of officers and directors which was approved by voice vote. The present officers and many directors will continue in office with the addition of the following new directors: L. C. Allenbrand, Caterpillar Tractor Company, York, Pa.; William Bateman, Wayne Pump Company, Philadelphia, Pa.; Robert R. Williams, Girard Trust Corn Exchange, Philadelphia, Pa.

Mr. Webster then announced the recipient of the John C. Jones Medal, awarded annually by the Philadelphia Post to a person who has been outstanding in his interest in ordnance and the national defense. The medal was founded in honor of Mr. Jones who was chief of the Philadelphia Ordnance District during World War I and many years thereafter. The recipient was Al Gilmer, a colonel in the Army Ordnance Reserve, a former president of the Philadelphia Post, and now on its board of directors.

Dr. William H. Martin, Director of Research and Development in the Office of the Secretary of the Army, the guest speaker of the meeting, was introduced by Mr. Sweetser.

Dr. Martin discussed research in the fields of firepower, mobility, and communications. He allotted most of his remarks to the background and progress in missile developments.

Others at the head table were: V. R. Rawlings, manager, Martin's Baltimore plant; H. Paul Gant, a Post vice-president; Arthur J. Seiter, Gates Engineering Company, a Post vice-president; E. J. Langham, Sun Oil Company; and Col. H. R. Thayer, deputy chief, Philadelphia Ordnance District.

To add additional zest to the meeting a special bus and walking tour started at the Martin Airfield where a Matador missile on display on its launcher was put through its paces, including static firing of the ramjet engine.

There followed a highly interesting inspection trip through part of the assembly shops and the machine areas. Here it was evident that Martin and the Navy were going full speed ahead on the P6M (Seamaster) program. Finally the big presses were exhibited as they turned out large wing and fuselage parts for the P5M and P6M flying boats.

At 9 p.m. sharp all hands were reëmbarked in the special train and headed back for Philadelphia.

Far East Post Established by Association—First Outside Continental U. S.

At Yokohama, Japan, an organization meeting of members of the A.O.A. was held early in May to discuss the formation of an A.O.A. Post in the Far East. Among the many present were representives of the Army Logistical Depot, the Army Ordnance Depot at Oppoma, the Ordnance Support Depot at Camp Drake, and several Ordnance subdepots and headquarters units.

Lawrence A. Martin, president of the American Ordnance Association of the Far East, a local organization, was presiding officer. It was voted that in view of the membership being well over 100, including 32 regular association members of long standing, application should be made to A.O.A. headquarters for the establishment of a Far East Post.

The formation of this Post was approved in Washington, and the unit planned to hold its inaugural meeting on Friday, June 28th. This will be a new venture for the Association as it will establish the first Post of the A.O.A outside the continental limits of the United States.

New York Post Honors A.O.A. President on Occasion of Its Thirty-sixth Meeting

The New York Post of the Association celebrated its thirty-sixth annual meeting with a President's Dinner in honor of Gen. Benjamin W. Chidlaw, national A.O.A. president.

The dinner meeting was held in the grand ballroom of the Sheraton-Astor Hotel, New York City, on Tuesday, April 23rd, with over 300 members in attendance and was preceded by an informal reception.

Lieut. Gen. Leslie R. Groves, president of the Post and presiding officer, called on Howard E. Isham, a Post vice-president to give the invocation.

After welcoming the members and reminding them of the advantages of the A.O.A., General Groves invited Hartley W. Barclay, a Post vice-president, to read the preamble to the A.O.A. constitution. Lieut. Col. J. W. Graham, Post secretary-treasurer, then reported that the Post's membership and finances were both in very good shape. He was followed by Capt. J. M. P. Wright who brought the latest news from national headquarters of the Association.

General Groves then introduced General Chidlaw who gave an excellent address

based on his own experience of the growth of the Air Force and its present capabilities.

The general referred briefly to World War II, the letdown that followed, and the upsurge in strengthening our defenses under the impact of Communist development of nuclear weapons and supersonic aircraft and the Korean war. He noted that, step by step, we developed antiaircraft missiles, faster interceptors, three arcs of early-warning lines, and, finally, with operational speeds too fast for manual control, the Sage system—an almost fully automatic control and direction device for our air defenses.

General Chidlaw emphasized that throughout these developments service cooperation increased steadily, until in 1954 a truly joint command for Continental Air Defense was established. "No problem arose that we couldn't solve with men of good will over a cup of coffee," he said.

His talk was happily interspersed with many illustrative personal anecdotes that left the audience with the feeling that they also had participated closely in the build-up of our air defense.

Surface Preservation Committee Meets at Rock Island Arsenal

The Surface Preservation Committee met at Rock Island Arsenal, Ill., on March 5, 1957. In opening this twenty-first meeting of the group, Chairman E. A. Stockbower introduced Col. A. R. Cyr, commanding officer, Rock Island Arsenal, who welcomed the members to the arsenal.

Colonel Cyr then introduced Brig. Gen. T. A. Weyher, commanding general, Headquarters, Ordnance Weapons Command, who explained the function of his command.

The technical program included discussion of the following topics:

1. *Proposed Military Specification MIL-P, Phosphate Coating Compounds, for Phosphating Ferrous Metals.*

L. F. Fall of Watertown Arsenal presented an excellent discussion of the draft. Many members responded with comments on this draft.

M. B. Roosa stated that this proposed specification would solve a supply and stocking problem as well as provide a means for product standardization as to competitive bidding. However, he pointed out that in accomplishing this end the specification was tending toward an oversimplification of the phosphating compounds which, in his opinion, would not be to the best advantage of the users.

J. J. Basch emphasized that a chemical composition specification does not have the status or the value of a performance specification. It is realized that the proposed specification is for the use of Government facilities only to purchase materials of this type. The restrictive nature of a purchase description of this kind may rule out the use by governmental agencies of all newer materials as they are developed by research.

L. O. Gilbert of Rock Island Arsenal gave some interesting comments on this specification, stating that it was only to be used by the Ordnance group on phosphating operation.

H. L. Ammlung of Aberdeen Proving Ground stated that the only use of this specification is for Government use in Government operations. The specification is not for use by suppliers but can be used as a guide for working on Government orders. The suppliers will still have to meet performance specifications.

2. *Finishing Steel for Structural Aircraft Applications.*

J. Teres, Wright Air Development Center, discussed plating technique and hydrogen embrittlement. The major portion of the nonstainless-type steels for aircraft applications have been plated with cadmium. Two problem areas with cadmium plate on present modern and future aircraft indicate that the use of such plate will be less in the future.

The first problem is one of hydrogen embrittlement. Another deleterious phenomenon is associated with cadmium plate in contact with steel at or above the melting point of the cadmium. Metallurgraphic examination showed evidences of intergranular penetration by the cadmium. As the speed of aircraft goes up, this latter effect becomes more important.

In addition to their higher hot strength properties, the SAE H-11 alloys possess the advantage of higher draw temperatures than the SAE 4340 series steels and as a result would be expected to have lower internal stresses because of the heat treating.

It was concluded that high-strength steels are here to stay as a part of future high-performance aircraft, cadmium is on the way out, but that hydrogen embrittlement in some form will probably be a problem for some time to come.

3. *Specification TPT 664 for Cavity Liners.*

H. L. Ammlung of Aberdeen Proving Ground discussed this specification and has found the following best suited for cavity liners: (1) pure acrylic not modified, (2) polyvinyl butryal used in chlorate primer cavities, (3) chlorinated paraffin. He stated that work was in progress on liners for shells and bombs and that what was wanted to do this job was the compatability with explosives: (1) pure coating, (2) pure mixture, (3) heat check loss.

A. G. Tomassetti of Frankford Arsenal stated that for the protection of the interior of caliber .45 and .50 and 20-mm. and 50-mm. ammunition the problem stems from the fact that parts for these are manufactured at a different place from that at which they are loaded. It seems that the case and projectile are manufactured at two different places and then the ammunition is loaded at the third place. Many parts are rusted before assembly. Some of these component parts are stored for as long as one to two years. He recommended the following requirements for the coating inside the casing: (1) Base of application, (2) Conductivity of material, (3) Compatability with propellant, (4) Protection, (5) Performance in the weapon.

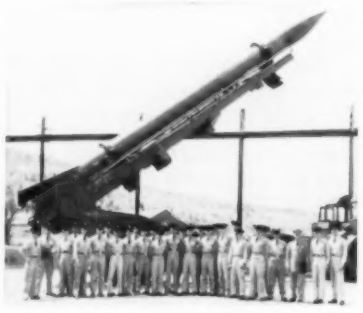
J. L. Flynt discussed rusting problems in the bursting casing in chemical shells.

The next meeting of the Surface Preservation Committee will be held at the Naval Research Laboratory, Washington, D. C., on October 1, 1957.

The Citadel Post Makes Field Trip to Redstone, Sees Missile Facilities

The Citadel Post made a field trip to Redstone Arsenal, Huntsville, Ala., on April 4-5, 1957. The group was accompanied by Capt. J. E. Carr, Chapter adviser.

Following breakfast, the group received a formal welcome from Brig. Gen. John



Citadel members inspect Corporal missile.

A. Barclay, deputy commander of the Army Ballistic Missile Agency, and a brief explanation of the mission of ABMA by Col. Howard E. Von Kaenel, director of the Training Division.

The group was then taken on a tour of the grounds of Redstone Arsenal. This also included the Ordnance Guided Missile School and the Thiokol Chemical Company facilities. The morning ended with a briefing on the Redstone missile.

The afternoon began with a discussion in the ABMA Headquarters Building on missile information. Following this interesting and informative talk, the group was taken to the ABMA testing grounds where the members witnessed a static firing of the Jupiter missile. A tour of the Fabrication Laboratory concluded the day-long visit.

A buffet dinner was served at Redstone Arsenal Officers' Club at 6 p.m. Saturday morning the group left by bus to return to The Citadel.

Middle Tennessee Chapter Started by Cincinnati Post at Nashville

The new Middle Tennessee Chapter of the Cincinnati Post exploded into being with a record turnout of one hundred members. The inaugural ceremonies and dinner meeting were held at the Andrew Jackson Hotel, Nashville, Tenn., on Thursday, April 25th.

After a reception for the guest of honor, Maj. Gen. Troup Miller, U.S.A.F., Commander, Arnold Engineering Development Center, the dinner meeting was opened with an invocation by Macklin Davis.

Present at the inaugural meeting of the Middle Tennessee Chapter were, left to right: Maj. Gen. Troup Miller, Commanding General, Arnold Engineering Development Center, guest of honor; Perrin G. March, III; F. Donald Hart, chairman; Robert S. Gruver, Cincinnati Post president; and Col. L. C. Sorensen.

Chairman of the meeting was F. Donald Hart, vice-president of Temco, Inc., who led the effort to establish the Chapter. Mr. Hart introduced the guests at the speakers' table and presented the men who had helped form the Chapter. The organizing committee included the newly elected officials of the Chapter and Shepard Schwartz, May Hosiery Mills; Hank Waechter, Edwin A. Keeble Associates, Inc.; Maj. Carl C. Chandler, Nashville Branch, Cincinnati Ordnance District; Dudley Galloway, Temco, Inc.; and Richard Douglas, Jr., Temco, Inc.

Also recognized by the chairman were visiting members from the Cincinnati Ordnance District and Army Ordnance officers from Fort Campbell.

The Chapter's by-laws, previously distributed, were adopted by voice vote, and the initial slate of officers presented by Nominating Committee Chairman Schwartz was accepted unanimously. The new officers are:

Chairman, Mr. Hart; vice-chairman, Neil H. Cargile, president, Allen Products, Inc.; secretary-treasurer, Paul Clements, Philips and Buttorff; and the following directors: Capt. R. L. Adams, U.S.N. (Ret.), manager, Lyon, Incorporated; Wesley H. Dyer, Metal Products Inc.; Edwin A. Keeble, president, Keeble Associates; and Brig. Gen. H. A. Nisley, Warren Brothers.

National headquarters was represented by Capt. J. M. P. Wright who discussed the background, aims, and purposes of the Association, read the preamble to the A.O.A. constitution, and presented the Chapter charter to Mr. Hart on behalf of the Association.

Robert S. Gruver, president of the Cincinnati Post, welcomed the new Chapter and described the objectives of the Post. With Mr. Gruver from the Cincinnati Post were Perrin G. March, III, Post vice-president, and Lennard C. Sorensen, secretary-treasurer.

Brig. Gen. Frank McCoy, U.S.A.F.R., was called on to introduce General Miller, the guest speaker.

General Miller told the audience about the vast engineering development center at Tullahoma, Tenn., that he commands. His excellent talk was well illustrated with colored slides and amazing film clips of high-speed tests in the new wind tunnels at Arnold Engineering Development Center.

He mentioned several important "in-house" developments designed by his own engineers but, he explained, the principal mission of Arnold was testing for industry of aircraft and missile propulsion units of all types. There eventually will be equivalents at full scale of over Mach 5 and 100,000 feet altitude in the tunnels.

The general noted that although the power requirements of AEDC are enormous, costing now some $300,000 a month before all tunnels are completed, the ability of the largest tunnels to test complete engines will save millions of dollars and greatly reduce the risks in comparison with airborne testing.

Albuquerque Post Holds Joint Meeting with Fuze Committee at Kirtland AFB

The Albuquerque Post held a joint dinner meeting with the A.O.A. Fuze Committee on Tuesday, April 16th. The Post and Committee members joined forces at the Kirtland Air Force Base Officers' Club for the reception and dinner.

Rear Adm. W. W. Juvenal, Post president, presided and introduced his new officers and the Fuze Committee officials. No formal speaker was scheduled as most of the members had been attending seminars all day, but several informal talks were made.

Col. William B. Kieffer, Deputy Commander of the Air Special Weapons Command, outlined the numerous tests and developments in which his activity is engaged.

Admiral Juvenal recounted the background of the establishment of the Albuquerque Post and its plans for the future.

Loading Committee of A.O.A. Meets at Burlington, Iowa

The annual 1957 meeting of the Loading Committee, Bomb and Artillery Ammunition Division, American Ordnance Association, was held at Burlington, Iowa, on March 13-14, 1957. Presiding at the technical sessions of this meeting were the two cochairmen of this Committee: Brig. Gen. Joel G. Holmes, Mason & Hanger-Silas Mason Company, plant manager, Iowa Ordnance Plant, Burlington, Iowa; and Robert H. Kellogg, Procter & Gamble Defense Corporation, plant manager, Milan Arsenal, Milan, Tenn.

The first day's meeting was called to order at 9 a.m. by cochairman General Holmes at the Hotel Burlington in Burlington, Iowa. As cochairman of the Committee and official host representing the Mason & Hanger-Silas Mason Company, General Holmes extended a warm welcome to the distinguished guests and Committee members attending the meeting. He introduced Lieut. Col. William F. Bobzien, Jr., Ordnance Corps, commanding officer of the Iowa Ordnance Plant, who welcomed the Committee and placed the facilities and personnel of the Iowa Ordnance Plant at their disposal.

The chairman reported that a number of high-ranking officials of the armed services who had been unable to attend the meeting had sent their regrets and General Holmes read a letter of greeting from the Hon. Wilber M. Brucker, Secretary of the Army:

"Thank you for your kind invitation to the Loading Committee Meeting of the Bomb and Artillery Ammunition Division of the American Ordnance Association. It would be a privilege to join you on 13-14 March if I were free to do so, but a prior official engagement makes it impossible for me to plan to attend.

"The studies your Committee makes are valuable, and I should like to congratulate the members on their contribution to our national defense."

General Holmes also read a letter from the Hon. Frank H. Higgins, Assistant Secretary of the Army (Logistics), who had definitely planned to be present but unfortunately was delayed at the last minute in Washington.

The following technical papers were presented and discussed during the day's session which lasted until after 4 p.m.:

Col. Charles K. Allen, deputy commander, Ordnance Ammunition Command, Joliet, Ill., "Accomplishment of the Ammunition Industry during 1956 with a Look into the Probable Trend of the Ammunition Program for the Ensuing Year"; Col. Ronald B. Currens, commanding Officer, ordnance Field Safety Office, Jeffersonville, Ind., "Management Responsibility in Safety"; H. M. Krengel, general manager, Ravenna Arsenal, Inc., Apco, Ohio, "General History of the Pneumatic Conveyor"; Paul B. Tweed, Picatinny Arsenal, Dover, N. J., "Loading and Safety Testing of Composition B"; B. T. Bernacchi, director of engineering, American Safety Razor Corporation, La Porte, Ind., "Solidification of Explosives."

Papers also were delivered by the following: H. B. Stevenson, chief technical engineer, Procter & Gamble Defense Corporation, Milan, Tenn., "Recent Developments in Automatic Equipment for Loading and Assembly of Ammunition on a Belt" and "Problems and Future Planning for Electrically Initiated Ammunition Items"; Robert Parker, Industrial Engineering Division, Picatinny Arsenal, Dover, N. J., "Comments on Process and Equipment Studies Under Way at Ordnance Loading Plants"; J. P. Zeigler, Ordnance Ammunition Command, Joliet, Ill., "Production and Process Engineering Plans and Progress"; L. R. Rothstein, technical director, Mason & Hanger-Silas Mason Company, Iowa Ordnance Plant, "The SPCC Melt-Pour-Cool Process—A New Application"; and Leland E. Starr, Jr., U. S. Naval Ordnance Laboratory, White Oak, Silver Spring, Md., "The Settling of Aluminum in Explosive Charges."

During the evening of the first day's meeting the group assembled at the Hotel Burlington for an enjoyable social hour and dinner. The technical session was reconvened the next morning at 9 a.m. and continued until noon with the presentation and discussion of the following papers:

Keith Waugh, Nebraska Ordnance Plant, Wahoo, Nebr., "Manufacture of the 750 Bomb Body"; J. A. Batley, Office, Chief of Ordnance, Washington, D. C., "Importance of the Professional, Technical and Diplomatic Attributes of Individuals Relating to Safety"; M. H. Wegener, division engineer, Mason & Hanger-Silas Mason Company, Iowa Ordnance Plant, Burlington, Iowa, "Future Loading, Assembling, Packing Line for 8-inch Shell"; J. Stewart Petersen, Day & Zimmermann, Inc., Texarkana, Tex., "Study of Modern Methods of Ammunition Loading"; Alva M. Major, director of production, Louisiana Ordnance Plant, Shreveport, La., "Improvement in the Process Used for Conditioning TNT Prior to Pouring"; and Harry Steinberg, Office, Chief of Ordnance, Washington, D. C., "Trends in Ammunition Development."

The afternoon of the second day was devoted to planned tours of the Iowa Ordnance Plant which were most informative to all members of the visiting group.

The comments of all those present at this meeting were highly complimentary and the many excellent technical papers were included in the minutes of the meeting which were promptly prepared and distributed.

The annual dinner meeting of the Los Angeles Post was a brilliant replica of the A.O.A.'s National Industrial Preparedness dinner at the Waldorf, surpassed only in the size of the New York seating list. The meeting was held in the grand ballroom of the Beverly Hilton Hotel on Friday, April 12th, and attended by over 700 members and guests.

Patrick Lizza, the recently elected president of the Post, presided from a 3-tiered dais where an impressive assembly of the leading citizens and officials of Southern California were seated, interspersed with distinguished officers of the Army, Navy, Air Force, and Marine Corps.

The meeting opened with the National Anthem sung by Catherine Corday followed by the invocation by Comdr. L. W. Meachum, Chaplain, 3rd Marine Aircraft Wing, El Toro, Calif. H. Leslie Hoffman, of Hoffman Laboratories, Inc., a director of the Post, was toastmaster.

The guest of honor, Gen. Willard G. Wyman, Commanding General, United

Members of the Loading Committee who attended meeting at Burlington, Iowa.

States Continental Army Command, was introduced by Col. W. S. Broberg, Post vice-president. General Wyman spoke on "Preparedness in the Nuclear Age." He outlined the many changes in tactical organization and dispositions required in fighting with atomic weapons that in turn have required new and more arduous training techniques.

General Wyman emphasized that we no longer can train men in a few months since nuclear warfare requires four months just to condition a soldier for survival in the battle area.

General Vissering Addresses Meeting of New Orleans Post

The New Orleans Post held its spring meeting at the St. Charles Hotel, New Orleans, La., on Wednesday, April 10th. W. L. Love, acting president of the Post and presiding officer, appointed a membership and a nominating committee with E. W. Stauss of Stauss & Hass, Inc., and H. A. Long, Rheem Manufacturing Company, respectively as chairmen.

L. A. Reber, regional manager of Rheem Manufacturing Company, requested the floor in order to present a Certificate of Appreciation to Mr. Love which was awarded to him by national A.O.A. headquarters for outstanding leadership in his previous tour as Post president.

The guest speaker was Maj. Gen. Norman H. Vissering, commanding general of the Gulf Transportation Terminal Command, who spoke on "Current Concepts of Army Operations as They Affect Industry." He explained the Army's plans for handling the nationwide rail, truck, and water shipping facilities in the event of a national emergency.

Among those at the head table during the spring meeting of the New Orleans Post were, left to right: John C. Hill, Jr.; Thomas Hoskins; Maj. Gen. Norman H. Vissering, guest of honor; William L. Love, acting president; Harry A. Long; and Robert Eddy, III. The meeting was held at the St. Charles Hotel.

Admiral Sides Speaks to Members of Washington at Luncheon Meeting

On Thursday, April 18th, the Washington Post closed its season of monthly luncheon meetings with an excellent turnout and a great talk by the guest of honor and guest speaker, Rear Adm. John H. Sides, Deputy to the Special Assistant for Guided Missiles.

Over 300 members and guests gathered to vote on the election of officers and directors and close the season with proper ceremony. As the first matter of business the presiding officer and Post president, Franklin B. Reybold, presented an A.O.A. tie chain to R. P. Williams for his efforts in obtaining new company and individual members for the Association.

A. E. Becker reported the slate of new officers and four new directors to serve until 1960. All were unanimously elected by voice vote. The new officials are: W. J. Sears, Rubber Manufacturers' Association, president; Ernest A. Tupper, American Can Company, and Stewart L. Magee, U. S. Steel Corporation, vice-presidents; Henry R. Long, Allegheny Ludlum Steel Corporation, secretary-treasurer.

The new directors are: Gen. Jacob L. Devers, Fairchild Engine & Airplane Corporation; Melvin B. Harris, Budd Company; John N. Quisenberry, Horne Brothers, Inc.; and Fred B. Zoll, Jr., Libbey-Owens-Ford Glass Company.

Admiral Sides gave an excellent summation of the guided-missile situation in the United States. He mentioned briefly the terrific advances that had been made in just twelve years in propulsion and electronics so that we are now able to tackle a new missile project with greater confidence that it can be completed in a reasonable time.

The admiral claimed that a new industry could be considered to exist although actually the missile work was being handled by aircraft and electronic companies and many allied suppliers.

Admiral Sides predicted that when operational commanders become completely familiar with the utilization of rockets and missile systems these systems would cost less than some of the present weapons we employ. For example, he pointed out that preparation to defend against enemy air attack now requires a great deal of refresher training, trial flights, and pilot replacement which would be eliminated to great extent when all interception is by missiles.

Distinguished guests at the speakers' table included Gen. Omar N. Bradley, chairman, Bulova Research & Development Laboratories; General Devers, a newly elected director of the Post; Hon. W. J. McNeil, Assistant Secretary of Defense (Comptroller); Maj. Gen. J. H. Hinrichs, Deputy Chief of Ordnance; Lieut. Gen. S. E. Anderson, U.S.A.F., Director, Weapons Systems Evaluation Group; Rear Adm. W. F. Raborn, Director, Special Products Division, Navy Bureau of Ordnance; Brig. Gen. C. J. Hauck, Jr., Deputy Assistant Secretary of Defense for Legislative Affairs; and George M. Riveire, A.O.A. Council representative.

Midwest Post Sponsors Secretary Higgins' Panel on Industrial Procurement

The Midwest Post was one of the sponsors of a meeting at which Assistant Secretary of the Army for Logistics Frank H. Higgins and his panel conducted an Industrial Procurement Conference. The panel meeting on Friday, April 12th, held at the Muehlebach Hotel, Kansas City, Mo., was followed by a dinner in the Colonial Ballroom of the hotel in honor of Secretary Higgins and Senator Stuart Symington of Missouri.

The panel members who assisted the Secretary were: Maj. Gen. Henry R. Westphalinger, director of procurement, Office of the Deputy Chief of Staff for Logistics; Brig. Gen. Jean E. Engler, chief of the Industrial Division, Office of the Chief of Army Ordnance; Lieut. Col. William W. Thybony, chief of the Procurement Division, Office of the Assistant Secretary of the Army (Logistics); Jack W. Askins, Small Business Adviser to the Assistant Secretary of the Army (Logistics).

The Secretary and his group discussed the contract and inspection procedures used in Army procurement and the matter of preaward surveys. After each part of the presentation they were flooded with questions from the many A.O.A. members and guests who attended.

Army Ordnance School Headquarters To Be Named for General Vincent

At a formal dedication ceremony to be held on July 5, 1957, at Aberdeen Proving Ground, Md., the Army Ordnance School headquarters building will be named in honor of the late Brig. Gen. Thomas Kenneth Vincent, a former deputy commander of the proving ground and a staff consultant of the Ordnance Association at the time of his death last year.

Lieut. Gen. E. L. Cummings, Chief of Ordnance, U. S. Army, is to give the memorial address to the many distinguished guests and friends invited to pay tribute to the late well-known Ordnance officer. Mrs. Vincent, who resides in Highland Park, N. J., is to be an honored guest at the ceremony.

Vincent Hall, Headquarters Building of the Ordnance School at Aberdeen.

Over 1,000 officers and men, including the School Honor Guard, will march in the parade in honor of General Vincent, whose name has been engraved on a bronze plaque at the entrance of the dedicated building. Prominently displayed in Vincent Hall is a plaque reading:

"So named in memoriam of Brigadier General Thomas Kenneth Vincent, United States Army (Retired), whose service as deputy commander of Aberdeen Proving Ground from December 1948 to June 1952 and concurrently as Commanding General of The Ordnance Training Command and Commandant of The Ordnance School from August 1951 to November 1951 reflected great credit upon the United States Army and the Ordnance Corps and attested to his own distinguished military career."

General Vincent was assigned to Aberdeen Proving Ground in December 1948 as deputy commander and held that position until June 1952. In August 1951 he assumed command of the Ordnance Training Command with headquarters at Aberdeen Proving Ground and was concurrently the commandant of the Ordnance School from August to November 1951.

In June 1952 he took command of Redstone Arsenal, Huntsville, Ala., where he remained until his retirement in August 1954. From then until he death on September 9, 1956, he was active with the American Ordnance Association at Washington as consultant for Technical Divisions and Committees.

To General Vincent, who served the Army and the Ordnance Corps with such distinction, Vincent Hall will be an enduring memorial.

A.O.A Container Committee Meets at the Louisiana Ordnance Plant

The annual meeting of the Container Committee, Bomb and Artillery Ammunition Division of the American Ordnance Association was held at the Louisiana Ordnance Plant, Shreveport, La., on May 14-15, 1957.

The presiding officer throughout the meeting was Harvey C. Simms, committee chairman of the Cleveland Container Company, Washington, D. C. Maj. Houston P. Willis, commanding officer, Louisiana Ordnance Plant, and James A. Ward, general manager, Louisiana Ordnance Plant, Remington Rand Division, Sperry Rand Corporation, opened the morning session with warm words of welcome.

The following technical papers were presented: "Aerial Delivery of Ammunition," by George Buck, Picatinny Arsenal.

"Recent Developments in Guided Missile Packaging," by Harold Decot, Craig Systems, Inc.

"Comments on Wooden Box Specifications and Inspection," by Thomas J. Munroe, Maraine Box Company, and President of the National Wooden Box Association.

"Study of Linderman Joints for Ammunition Pallets," by Tom B. Heebink, Forest Products Laboratory.

"A Look at the Customers Interests," by Col. Thomas L. Gaines, U.S.A. Ret., Louisiana Ordnance Plant

"Some Aspects of Metal Container for Future Consideration of Ordnance Packaging," by A. L. Hartung, National Can Corporation.

"Some Practical Aspects of Metal Coating Requirements in Shell Packing," by Clarence E. Ryan, Jr., Caspers Tin Plate Company.

"Loss and Damage Prevention on Car Loading of Ammunition and Explosives," by Thomas P. Wharton, Container Laboratories, Inc.

"Comparative Powder Containers," by Charles Edwards and Charles E. Norquist, Hercules Powder Company and Norquist Products, respectively.

"Economic Consideration of Container Design," by Roland E. Seely, Naval Ordnance Laboratory.

"Observations of Ammunition in Depot Storage," by C. V. Parker, Office, Chief of Army Ordnance.

"Use of Expanded Polystrene for Packaging Mine Items at Louisiana Ordnance Plant," by Harry E. Guenzler, Louisiana Ordnance Plant.

A reception and dinner were held to close the day's activities.

On May 15th, those in attendance spent an interesting morning on a specially conducted tour of the shell-manufacturing line and the loading lines of the Louisiana Ordnance Plant.

Rutgers University Chapter of New York Post Holds Campus Meeting on April 11th

The Rutgers University Chapter of the New York Post held a well-attended meeting on the campus on Thursday, April 11th.

James J. Curtin, Jr., Regina Corporation, discussed the procedures and problems involved when a plant must shift its operations from the manufacture of peacetime goods to armament. Mr. Curtin's ability to draw on his personal experience made his talk especially interesting to the student members.

At a business session Donald J. Abrams was elected to fill the vacant position of Chapter secretary. *(Continued on p. 82)*

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Yorktown Chapter of Washington Post Meets at Williamsburg, Va.

A large number of A.O.A. members from the tidewater area of Virginia assembled at the Williamsburg Lodge, Williamsburg, Va., for the spring meeting of the Yorktown Chapter of the Washington Post on Monday, April 8th.

Members and guests from all the services and the local industries were on hand for a preliminary reception to greet the guest of honor, Rear Adm. William K. Mendenhall, Jr., Commander, Operational Development Force, Atlantic Fleet.

After the invocation by the Rev. J. W. Brown, Williamsburg Methodist Church, the assembly was welcomed by Trist B. McConnell, presiding officer. Baxter C. Carr, chairman of the arrangements committee, then introduced the distinguished guests.

Admiral Mendenhall in speaking on the need for a continuing defense pointed out that the combination of the shrinkage of time and the infinite power of modern weapons presented a future clouded by uncertainty. He emphasized that this Nation must stay strong to make war impossible because he felt that war would only come if the Communist forces thought they could win readily; and with leaders dedicated to attempt to rule the earth, the Communist threat was ever present.

As one of the organizations that ensures the best equipment for the country's defense, the admiral elaborated on the mission of his Command, the Operational Development Force. He explained that it was a practical activity whose primary consideration for all equipment tested was whether it would work aboard ship and would be of value to the fleet. In many cases these tests revealed ways of improving prototype armament and even means of reducing its cost of production.

Admiral Mendenhall was then presented by George Svadeba, President-elect of the Chapter, with a membership in the American Ordnance Association.

At the request of the presiding officer, Capt. J. M. P. Wright, from A.O.A. national headquarters and also representing the Washington Post, introduced the newly elected Chapter officers. These were: W. C. Ranes, U. S. Naval Mine Depot, vice-president; E. E. Mason, U. S. Naval Mine Depot, secretary; and F. E. Kinsinger, U. S. Naval Mine Depot, treasurer.

Mr. Svadeba took the chair and as his first official act presented Dr. U. Cormier of the Naval Mine Depot with an A.O.A. decoration in recognition of his twenty-five years as a member of the Association and the unfailing support he had contributed to help establish the Yorktown Chapter.

Cumberland Valley Chapter of Philadelphia Post Meets at Mechanicsburg, Pa.

The new Cumberland Valley Chapter of the Philadelphia Post turned out in full force for their second meeting at the Naval Supply Center at Mechanicsburg, Pa., on Thursday, March 28th. The luncheon meeting was held at the Commissioned Officers' Mess where over 140 members, including more than 80 from the Ordnance Supply Office at Mechanicsburg, and guests gathered to welcome Rear Adm. David M. Tyree, Superintendent of the Naval Gun Factory in Washington.

Present at Cumberland Valley Chapter meeting of Philadelphia Post were, left to right: Capt. W. E. Mornig, Rev. B. V. Lavey, and Col Frederick Waite.

At the conclusion of the meeting the crowd embarked in buses for a tour of the vast array of storage sheds where the Ordnance Supply Office maintains the spare parts for the Navy's armaments.

Chapter Chairman William H. Strauss, Waynesboro Manufacturers Association, the presiding officer of the meeting, called on the Rev. Benjamin V. Lavey, rector of Trinity Episcopal Church, Chambersburg, for the invocation. Rear Adm. S. N. Edson, commander of the Naval Supply Depot, welcomed the guests. Capt. J. M. P. Wright, from A.O.A. headquarters, then presented a certificate of membership to Admiral Edson.

The admiral briefly described the function of the Naval Supply Office and introduced the guest of honor, Admiral Tyree, presenting him with a 3-year membership in the American Ordnance Association.

(Continued on p. 84)

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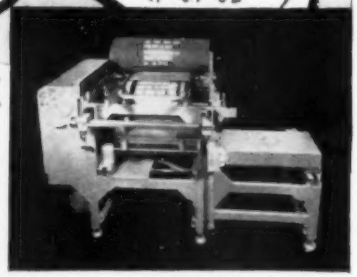

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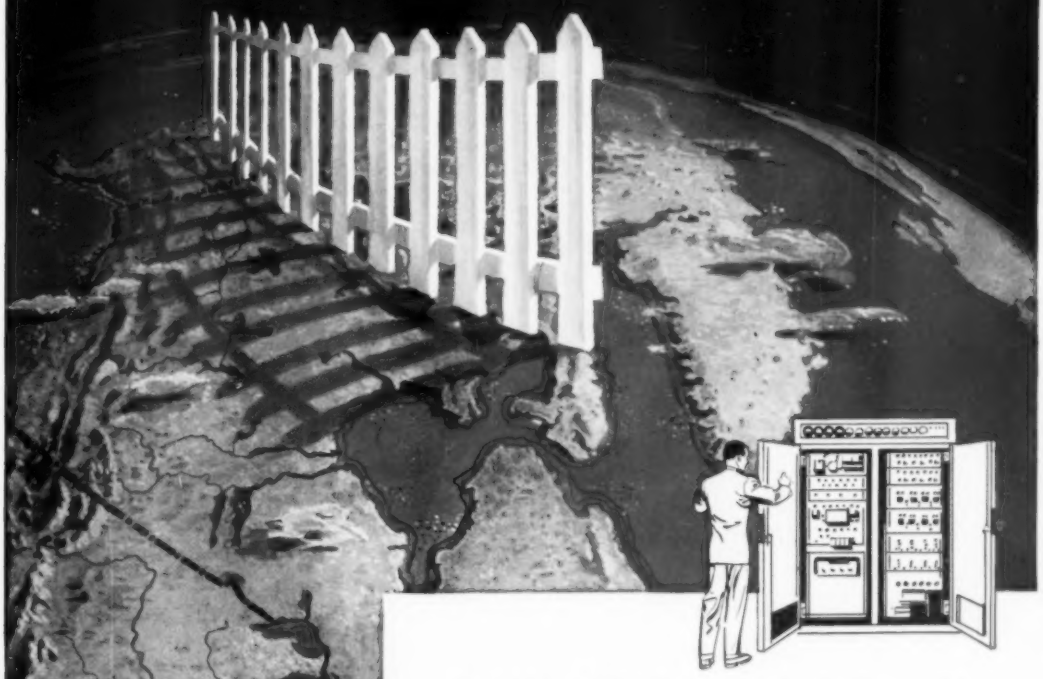

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Admiral Tyree recounted the early history of the Naval Gun Factory, which was originally a shipyard and the oldest naval shore establishment, dating from 1799. The Naval Gun Factory armed the Great White Fleet in the early 1900's, produced the greater part of naval armament for World War I, and in World War II served as a design and development center for industry and as a source for urgently needed items. The Admiral pointed out that American industry was called upon to supply the vast amount of equipment that only could have been furnished from America's great production lines.

Admiral Tyree revealed that the present activity of the Gun Factory, with its 7,500 employees, is the design and manufacture of pilot and prototype equipment, especially in rapid-fire medium-caliber guns, mines, and optical work. He pointed out that the Gun Factory must maintain high standards as in a national emergency the ordnance designers and mechanics of the Gun Factory must be prepared to go into the field and assist industry in the mass production of weapons.

Others at the head table were Capt. W. E. Moring, commanding officer, Ordnance Supply Office; Col. Frederick Waite, commanding officer, Letterkenny Ordnance Depot; Brig. Gen. R. W. Daniels, U.S.A., Ret.; Albert P. Schwarz, Chapter secretary; Comdr. James S. Spore, executive officer, Ordnance Supply Office; and Col. J. R. Jennings, executive officer, Letterkenny Ordnance Depot.

Quad Cities-Iowa Post Holds Its Spring Meeting at Rock Island

The Quad Cities-Iowa Post held its spring meeting at Rock Island Arsenal, Rock Island, Ill., on Friday, April 12th, following a tour of the Rock Island Arsenal Museum.

P. S. Mumford, past president of the Post presided in the absence of the president and vice-president. He introduced Col. A. R. Cyr, commanding officer of Rock Island Arsenal, who welcomed the members and guests, pointing out that the arsenal was proud to serve as host to the A.O.A. organization in view of their continuing efforts to combat apathy of the public in times such as this.

Mr. Mumford then read the preamble to the A.O.A. constitution and introduced Brig. Gen. T. A. Weyher, commanding general of the Ordnance Weapons Command, and Lieut. Col. Elmer Davis, executive officer of the Chicago Ordnance District. He also highly commended the representatives from the Reserve Officers' Association who were present at the meeting for their continued support of the A.O.A.

Because this was probably the last Quad Cities-Iowa Post meeting to be attended by General Weyher and Colonel Cyr, since both are to leave Rock Island Arsenal in the near future, Mr. Mumford recounted their past supporting activities of the Post and presented each with a token of the esteem in which they are held by the membership.

The speaker of the evening was J. S. Stoddard, vice-president of the Barkley & Dexter Company of Fitchburg, Mass. His subject was "Engineering Automatic Production," a very realistic appraisal of the automation story.

Mr. Stoddard pointed out that automation in some form dated back to the invention of the lever, winch, and wheel, and gave a brief historical outline. He explained the "brainstorming" pattern sometimes followed in order to develop these mechanisms, and also indicated that fully automatic production is not always economically sound practice. There are places for individually operated, semiautomatic, and automatic machines, and there apparently always will be.

He followed this outline with a personally narrated film showing the results of automation on six separate production cases in the textile, weld-rod, greeting-card, and canning-process industries.

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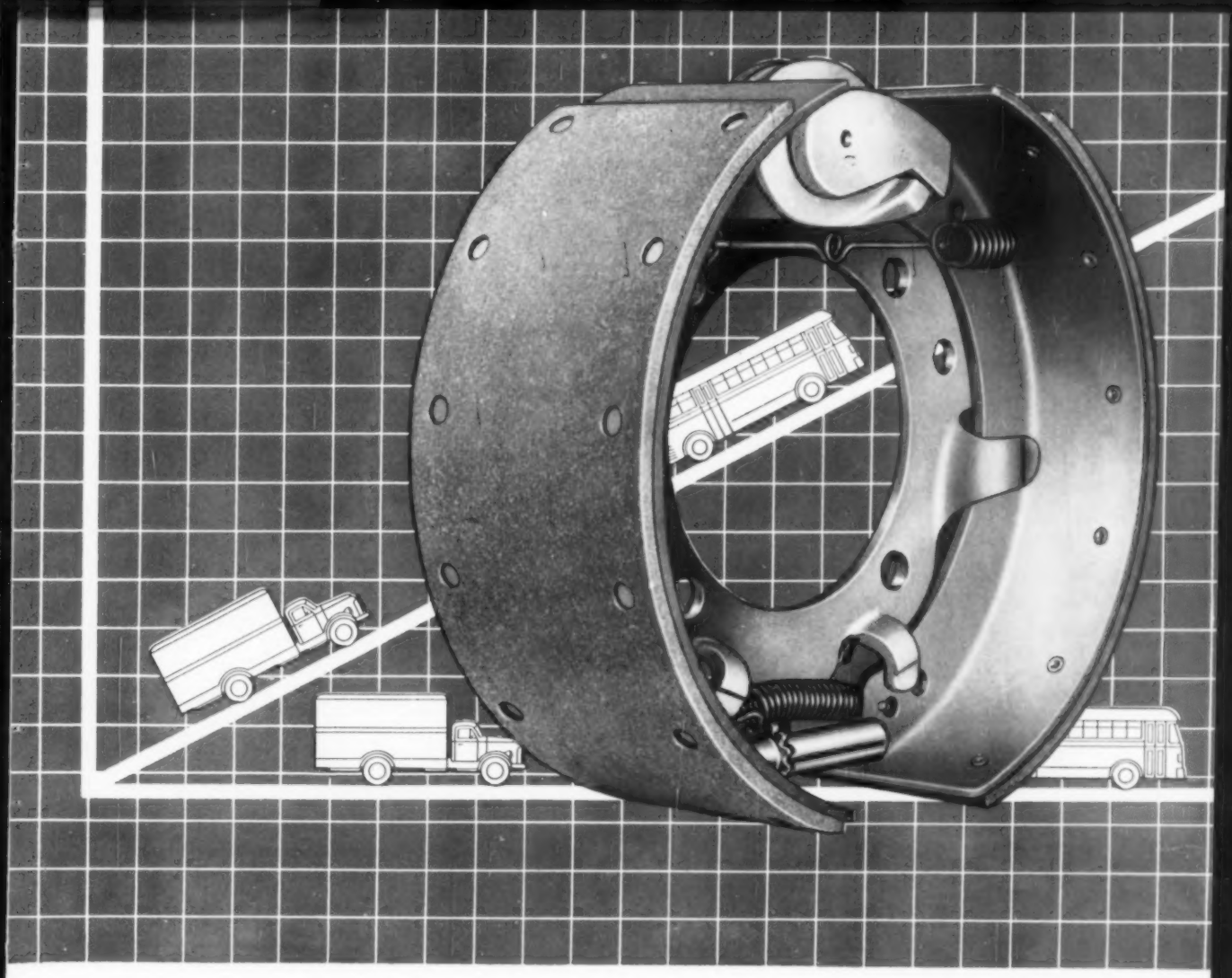
Large Turnout Attends the March Meeting of Washington Post at Country Club

The March meeting of the Washington Post was held at the Army-Navy Country Club on Thursday, the 21st, to greet the Hon. Richard E. Horner, Acting Assistant Secretary of the Air Force for Research and Development. Over 170 members and guests were on hand including 15 new members from the Maintenance Branch, Ordnance Field Service Division.

The presiding officer was Col. Franklin B. Reybold, Post president. With Colonel Reybold and Secretary Horner at the head table were Rear Adm. James Russell, Chief of the Navy Bureau of Aeronautics; Maj. Gen. F. A. Hansen, chief



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of the Ordnance Field Service Division, Army Ordnance; Col. Leo A. Codd, executive vice-president of the A.O.A.; W. J. Sears, Post vice-president, Stewart L. McGee, Post secretary, and Fred Zoll, Libby-Owens-Ford Glass Company.

Secretary Horner spoke on the problem of integrating unmanned weapons into the operational units of the Air Force. He noted the benefits in using guided missiles and also discussed the many problems in their development due to technical complexities and the exhaustive check-outs required to ensure reliable operation.

Secretary Horner pointed out that the manned aircraft is still essential where a high degree flexibility or accuracy is required.

General Colby Addresses Meeting of Capital Cities Post at Schenectady, N. Y.

The Capital Cities Post held its winter meeting at the Edison Club, Schenectady, N. Y., on Thursday, March 7th. The presiding officer, A. A. K. Booth, Post president, announced the proposed slate of officers for 1957-1958 who are: A. M. Demont, General Electric Company, president; E. S. Mathews, Watervliet Arsenal, first vice-president; R. L. Fryer, Alco Products, Inc., second vice-president; R. A. Currier, Watervliet Arsenal, secretary-treasurer; E. D. Rhodes, F. C. Huyck & Sons, council representatives.

He also reported that the following men were proposed to serve as directors until 1960: H. L. Erlicher, Schenectady, N. Y.; R. L. Fryer, Alco Products, Inc.; W. Stuart, Watervliet Arsenal; P. G. Townes, General Electric Company.

The guest of honor and principal speaker was Brig. Gen. J. L. Colby, commanding general, Frankford Arsenal, Philadelphia, Pa. General Colby gave a most interesting description of the work at his arsenal and the close coöperation effected with industry. He also praised highly the assistance he received from the Technical Divisions and Committees of the A.O.A.

Maj. V. M. Tootle Presented Alden Award by Ordnance School at Aberdeen

The recipient of the year's Herbert W. Alden Award was Maj. Vernon M. Tootle, who was chosen the outstanding officer student of the Ordnance Officer Advanced Course (9-0-3) at the U. S. Army Ordnance School, Aberdeen Proving Ground, Md., May 24, 1957.

Col. Leo A. Codd, executive vice-president of the A.O.A., presented the $100 award to Major Tootle. The award is given annually in memory of the late Col. H. W. Alden, Ordnance Reserve, U. S. Army, to the outstanding member of the Ordnance Officer Advanced Class.

The Timken-Detroit Axle Company, of which Colonel Alden was chief engineer for many years, made available a principal sum of $5,000, the income from which is used to provide the cash award. Colonel Alden was a member of the Founders Committee of the Ordnance Association and one of it greatest enthusiasts. He died on November 11, 1950.

Major Tootle, a native of Georgia, was selected in competion with other members of his class on the basis of several predetermined criteria, which include class academic standing.

Commissioned a second Lieutenant in 1945, he served in Europe and Korea and was ammunition supply officer, Field Service Division, Office, Chief of Ordnance, Washington, D. C. Upon his recent graduation he joined the staff and faculty of the Ordnance School.

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Rio Grande Post Members from El Paso and White Sands Meet at Las Cruces

The Rio Grande Post held it winter dinner meeting in Las Cruces, N. Mex., on Friday, March 8th.

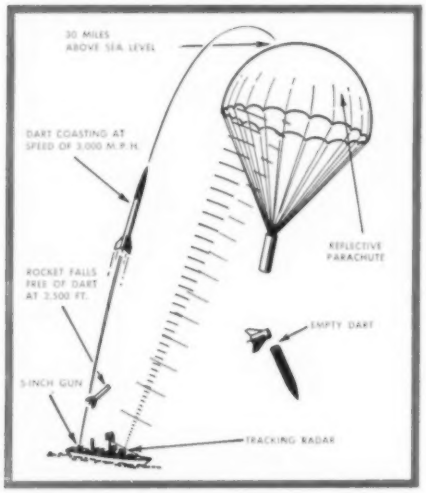
The combined attendance of members from El Paso and White Sands Proving Ground was over eighty.

El Paso members were especially indebted to Chris P. Fox, regional vice-president of the A.O.A., who arranged for a special bus.

Maj. Gen. W. E. Laidlaw, commanding general of White Sands Proving Ground and president of the Rio Grande Post, presided. Col. B. J. Hirshorn, nominating committee chairman, reported on a proposed ballot of officers and directors that was to be mailed out to all members.

The guest speaker was Kenneth R. Geiser, manager of the computing division of General Electric Company, who spoke on "Automation for Industrial Preparedness," explaining how the increasing use of principles of automation will create many more jobs than it abolishes. He traced the progress of automation from its early beginnings but emphasized that the switch to fully automated factories is a very gradual process. His talk was implemented by some excellent films and slides. *(Continued on p. 88)*

WHAT'S THE WEATHER 30 MILES UP?
CDC WASP REPORTS BACK IN 60 SECONDS



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Many Leaders of Industry and the Armed Forces Attend Meeting of A.O.A. Guided Missile Division

The manufacturing cost of missiles and rockets was emphasized at the semi-annual meeting of the Association's Guided Missile, Rocket and Jato Division at Redstone Arsenal, Huntsville, Ala., June 11-12-13, 1957. Hon. Frank H. Higgins, Assistant Secretary of the Army, addressed a dinner meeting of the Division and asked the industry representatives to give special attention to this phase of the program. His remarks met with enthusiastic approval. So also did the many evidences of missile progress apparent on all sides at Redstone.

Lieut. Gen. Emerson L. Cummings, Chief of Army Ordnance, also attended the meeting and congratulated the personnel of Redstone, of the Army's Ballistic Missile Agency there, and of the Ordnance Guided Missile School, also at Redstone. He also expressed gratification to the more than 250 representatives of American industry and our armed forces —Army, Navy, and Air Force—who were in attendance throughout the 3-day program. Many papers of exceptional technical importance were presented at symposiums during the three days.

Joint hosts at the meeting were the Commanding General of Redstone, Maj. Gen. Holger N. Toftoy, assisted by the Deputy Commander, Brig. Gen. John G. Shinkle; the Commanding General of the Army Ballistic Missile Agency, Maj. Gen. J. B. Medaris, assisted by the Deputy Commander, Brig. Gen. John A. Barclay; and the Commandant of the Ordnance Guided Missile School, Col. Henry S. Newhall.

The occasion was fittingly used for the dedication of Vincent Hall, a new and impressive classroom and laboratory building of the Ordnance Guided Missile School at Redstone. The late Brig. Gen. Thomas K. Vincent was the first commanding general of Redstone Arsenal. He retired from the service in August 1954 and was staff consultant for Technical Divisions and Committees of the American Ordnance Association at the time of his death, September 9, 1956. Secretary Higgins, General Cummings, and Adm. John E. Clark, Director of Guided Missiles, Office of the Chief of Naval Operations, participated in the ceremonies.

Also in attendance were the senior officers of the arsenal and the Army Ballistic Missile Agency and Brig. Gen. Francis J. McMorrow, Commanding General of the Ordnance Training Command, Aberdeen Proving Ground, Md. In the audience with the above participants were more than 200 members of the A.O.A. Division. The ceremonies were conducted by Colonel Newhall.

In the foyer of Vincent Hall is a portrait of General Vincent under which on a bronze plaque is the following inscription: "Vincent Hall—named in memory of Brigadier General Thomas K. Vincent, first commanding general of Redstone Arsenal, 1952-1954. For his inspiring leadership, devotion to duty, and humanitarian principles in dealing with members of his command."

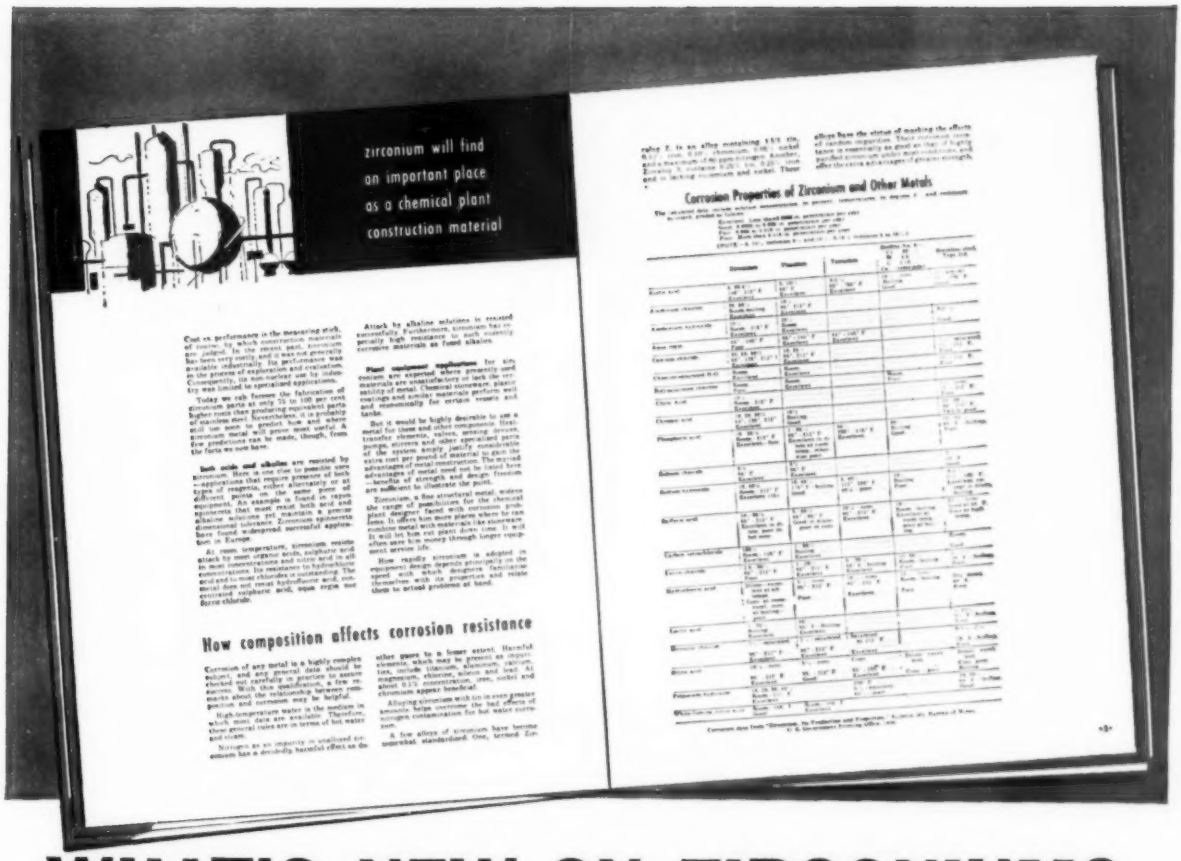
Following the dedication the guests viewed the largest display of Army guided missiles ever to be assembled in one place. They saw the Nike-Ajax, Nike-Hercules, Corporal, Redstone, Dart, Lacrosse, Hawk, Talos, Honest John, and Little John. Nike ground guidance equipment also was shown in operation.

At the dinner meeting held in the Officers' Club of the arsenal at which Secretary Higgins and General Cummings addressed the gathering there were senior representatives of the Army, Navy, and Air Force.

Throughout the 3-day program there were widespread expressions of praise for the phenomenal missile accomplishments at Redstone, its scientists, and industrial suppliers. The entire meeting was under the chairmanship of C. L. Eksergian, the Budd Company, assisted by S. C. Donnelly, Western Electric Company, as meeting manager; and C. A. Brady, Chrysler Corporation, as deputy meeting manager; Col. Miles B. Chatfield, as project officer for Redstone and his staff; and Brig. Gen. Burton O. Lewis, A.O.A. staff consultant for Technical Divisions and Committees. They arranged the program for this entire meeting which was of unusual significance. Louis Polk, vice-president of the Ordnance Association and president of Sheffield Corporation, Dayton, Ohio, attended the meeting.

During the day, the following groups held seminars: (1) Guidance and Control Committee, Dan E. Noble, Motorola, Inc., chairman; S. C. Donnelly, Western Electric Company, deputy chairman; (2) Structures Committee, Elmer P. Wheaton, Douglas Aircraft Company, chairman; C. A. Brady, Chrysler Corporation, deputy chairman. (3) Propulsion Committee, C. W. Guy, Rocketdyne Division, North American Aviation, Inc., chairman, assisted by Dr. H. M. Shuey, Rohm & Haas Company, deputy chairman; (4) Surface Handling Committee, E. A. Brittenham, Jr., Goodyear Aircraft Corpora-

(*Continued on p. 90*)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tion, assisted by Warren R. Stumpe, American Machine & Foundry Company, deputy chairman.

All arrangements for the meeting were carried through with efficiency and dispatch, eliciting well-merited praise for the staff at Redstone who cooperated so splendidly.

The following representatives of the military services and of industry were among those in attendance:

Talbert Abrams, Abrams Instrument Corporation; A. P. Adamson, General Electric Company; W. H. Ashford, Jr., Electric Storage Battery Company; C. F. Bachle, Continental Aviation & Engineering Company; Comdr. J. B. Balch, Navy Bureau of Ordnance; Alpheus M. Ball, Hercules Powder Company; Carl C. Ballard, Navy Bureau of Ordnance; H. W. Ballew, General Electric Company; Brig. Gen. John A. Barclay, Army Ballistic Missile Agency; James Allen Barr, Jr., Texas Power and Light Company; B. F. Bayuk, Martin Company; Eugene Bender, Office of Assistant Secretary of Defense; Robert S. Bergner, Alco Products, Inc.; Victor H. Bernardi, Office of Assistant Secretary of Defense; Levern R. Biasell, Chrysler Corporation.

Also, Col. E. Billings, Office of the Assistant Secretary of the Army; Paul M. Birk, Cornell Aëronautical Laboratory; Arnold Birnbaum, Federal Telecommunication Laboratories; R. Bodemuller, Bendix Aviation Corporation; C. A. Brady, Chrysler Corporation; G. F. Breitwieser, Radio Corporation of America; E. A. Brittenham, Jr., Goodyear Aircraft Corporation; Rufus P. Brown, Brown Engineering Company; David N. Buell, Chrysler Corporation; Comdr. Clifford W. Bundy, Navy Bureau of Ordnance; Capt. W. C. Butler, Jr., Navy Bureau of Ordnance; Lieut. Col. William E. Campbell, Office of the Assistant Secretary of the Army; Col. Miles B. Chatfield, Redstone Arsenal; Devern A. Chubb, Abrams Instrument Corporation; Col. C. W. Clark, Army Ordnance Research and Development.

Also, Rear Adm. John E. Clark, Office, Chief of Naval Operations; Col. Milton H. Clark, Army Ballistic Missile Agency; Leo A. Codd, Executive Vice-President, A.O.A.; Brig. Gen. Joseph M. Colby, Commanding General, Ordnance Ammunition Command; Comdr. Frank Colenda, Navy Bureau of Ordnance; Col. E. V. Conklin, Research and Development, Headquarters, U. S. Air Force; Vincent J. Cushing, Armour Research Foundation; Robert A. Cooley, C.B. & B. Chemical Corporation; Alfred Myer Cox, J. P. Devine Manufacturing Company; Elmer Cox, J. P. Devine Manufacturing Company; John J. Crowley, Office of Assistant Secretary of Defense; Lieut. Col. Paul J. Daigle, Redstone Arsenal; Lieut. Gen. E. L. Cummings, Chief of Ordnance, U. S. Army; Lieut. Col. Burleigh B. Dammond, Redstone Arsenal; Harold T. De Cot, Craig Systems, Inc.; Col. Martin L. Deguire, Redstone Arsenal; S. C. Donnelly, Western Electric Company; Col. William G. Downey, Office, Secretary of the Air Force; Anthony Demetrion, Northrop Aircraft, Inc.; C. L. Eksergian, Budd Company.

Also, J. R. Engdahl, Minneapolis-Honeywell Regulator Company; George Epps, Brown Engineering Company; Arnold Erlanger, U. S. Hoffman Machinery Corporation; Lieut. Col. Ernest W. Ewbank, Jr., Ordnance Guided Missile School; Frederick S. Eyestone, North American Aviation, Inc.; James Fagan, Redstone Arsenal; Charles Fisher, Norris-Thermador Corporation; David W. Fletcher, National Tube Division, U. S. Steel Corporation; Harvey W. Fritz, Redstone Arsenal; Loren E. Gaither, Magnavox Company; George C. Gentry, Edgewater Steel Company; G. J. Geyer, Navy Bureau of Ordnance; Harold Gill, Hoffman Machinery Corporation; F. R. Grubb, Navy Bureau of Ordnance; Joseph D. Haas, Olin Mathieson Chemical Corporation; Jesse M. Hadley, Bendix Aviation Corporation; Frederick M. Hakenjos, Hercules Powder; Eugene P. Halpin, Bendix Products Division, Bendix Aviation Corporation.

Also, William R. Hamel, Raytheon Manufacturing Company; Howard Hammond, Food Machinery and Chemical Corporation; Henry Handler, Office, Chief of Ordnance, U. S. Army; Lieut. Col. Herbert C. Hansen, Ordnance Guided Missile School; Arthur E. Harrison, Grumman Aircraft Engineering Company; John E. Hatch, Jr., Brown Engineering Company; Edward A. Hayes, Hughes Aircraft Company; Dr. Howard Hegbar, Goodyear Aircraft Corporation; Lieut. Col. Mac D. Hendricks, Ordnance Guided Missile School; David Hendrickson, Martin Company; Maj. George Hesse, Office, Chief of Ordnance, U. S. Army; Hon. Frank H. Higgins, Assistant Secretary of Army (Logistics); Dr. Shizuo Hori, Armour Research Foundation; Capt. Harry Hull, U. S. Naval Gun Factory; Morris B. Jobe, Goodyear Aircraft Corporation; Carl E. Johnson, Scaife Company; J. A. Johnson, Lockheed Aircraft Corporation; Nels Johnson, Philco Corporation.

Also, Thomas Johnson, Brown Engineering Company; Col. E. A. Kiessling, Research and Development, Development Headquarters, U. S. Air Force; Dolores M. Killion, Redstone Arsenal; A. C. Kramer; Rocketdyne, North American Aviation, Inc.; Comdr. Robert E. Kuntz, Navy Bureau of Ordnance; Comdr. W. R. Kurtz, Army Ballistic Missile Agency; Lieut. Col. William G. Kussmaul, Office,

(*Continued on p. 92*)

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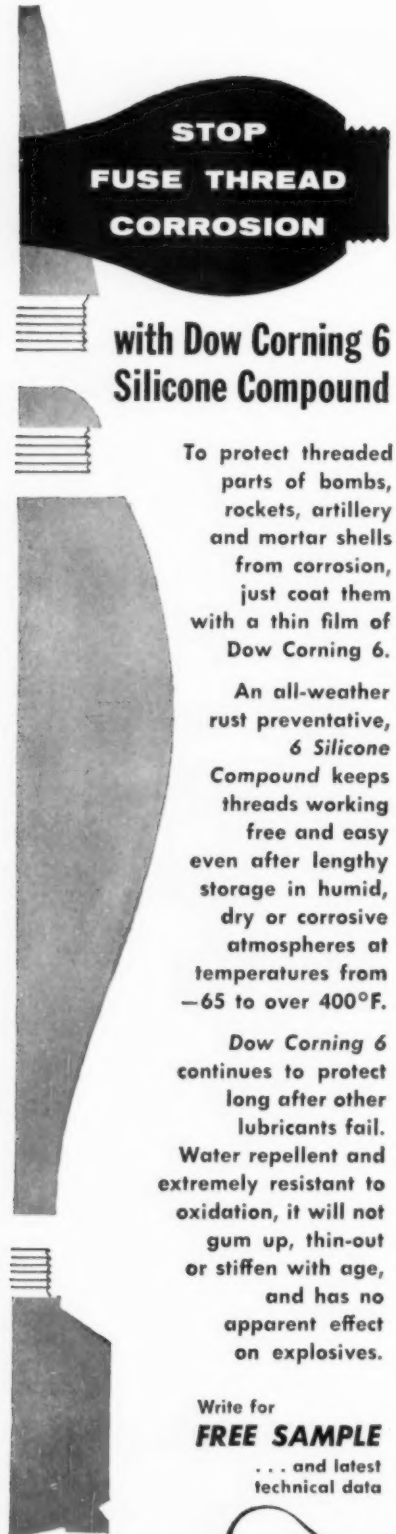

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Also, Robert K. Maddock, Fruehauf Trailer Company; William A. Mrazek, Army Ballistic Missile Agency; James C. Martin, Fruehauf Trailer Company; William M. Mebane, Thiokol Chemical Corporation; E. H. Meier, Hughes Aircraft Company; C. E. Meissner, Metallurgical Research and Development Company; Dr. G. H. Messerly, Bendix Aviation Corporation; Howard L. Miller, Republic Steel Corporation; J. L. Miller, Firestone Tire & Rubber Company; Richard Y. Miner, American Bosch Arma Corporation; Arthur G. Mirel, American Machine & Foundry Company; Gerard W. Mulder, Gibbs Manufacturing & Research Corporation; Francis J. Murray, Office of Ordnance Research, U. S. Army; Col. Henry S. Newhall, Army Ballistic Missile Agency; H. Erich Nietsch, Robinson Aviation, Inc.; Daniel E. Noble, Motorola, Inc.; P. W. Ott, Naval Air Missile Test Center.

Also Donald Patterson, Office, Secretary of Defense; Leonard L. Perlmutter, Navy Bureau of Ordnance; Comdr. Victor S. Pedersen, Army Ballistic Missile Agency; A. J. Peterson, Goodyear Aircraft Corporation; James R. Petters, Patrick Airforce Base, Fla.; J. Pinsky, Armour Research Foundation; Louis Polk, Sheffield Corporation; Herman Pusin, Martin Company; Col. Thomas J. Raber, Redstone Arsenal; Comdr. Rex Rader, Navy Bureau of Ordnance; Lieut. Col. Martin L. Raines, Army Ballistic Missile Agency; Mansel F. Rankin, Chrysler Corporation; Paul S. Reid, Convair Division, General Dynamics Corporation; Stewart E. Reimel, Lukens Steel Company; H. C. Riggs, Electric Storage Battery Company; Dr. H. W. Ritchie, Thiokol Chemical Corporation; M. S. Roberts, Convair Division, General Dynamics Corporation; H. J. Runstad, Boeing Airplane Company; L. M. Ruth, Navy Bureau of Ordnance; E. R. Sahag, Redstone Arsenal; Robert B. Rypinski, Chrysler Corporation; Dr. Martin Schilling, Redstone Arsenal; George A. Schlosser, Cornell Aëronautical Laboratory; M. F. Schoeffel, General Precision Equipment Corporation; Robert F. Schutz, Borg-Warner Corporation; Lieut. Col. Joseph B. Sestito, Office of Ordnance Research, U. S. Army.

Also, Brig. Gen. Harrison Shaler (U. S. Army, Ret.), Aërojet-General Corporation; Larry Shiller, Norris-Thermador Corporation; Brig. Gen. John G. Shinkle, Redstone Arsenal; Henry M. Shuey, Rohm & Haas Company; Comdr. Eugene Simpson, U. S. Naval Gun Factory; Brig. Gen. W. R. Slaughter, W. L. Maxson Corporation; Lieut. Col. Hobart V. Smith, Ordnance Guided Missile School; Bruce T. Stanaitis, Chrysler Corporation; Col. John M. Stark, Army Ballistic Missile Agency; Bailey T. Strain, Redstone Arsenal; Warren R. Stumpe, American Machine & Foundry Company; Capt. Leonard R. Sugerman, Research and Development Command, U. S. Air Force; William T. Sumerlin, Philco Corporation; Dr. Ralph C. Swann, Redstone Arsenal; J. W. Switack, Ingersoll Kalamazoo Division; Lieut. Col. William D. Sydnor, Office, Chief of Research and Development, U. S. Army; Maj. Gen. Holger N. Toftoy, Redstone Arsenal; F. W. Thompson, Firestone Tire & Rubber Company; Richard S. Townsend, Scaife Company.

Also, Vaino J. Vehko, Chrysler Corporation; Rear Adm. W. R. Vieweg, General Dynamics Corporation; Dr. Wernher Von Braun, Army Ballistic Missile Agency; Paul K. Weil, Paul K. Wyle Company; Bradley C. Welfare, Special Assistant for Procurement, U. S. Army; Raymond W. Wells, Aircraft Armaments, Inc.; Walter Wiesman, Army Ballistic Missile Agency; R. P. Williams, Jr., Williams Engineering Company; Maj. William K. Wittig, Ordnance Tank-Automotive Command; W. E. Woolwine, Northrop Aircraft, Inc.; Angus D. Young, Fruehauf Trailer Company; Frank Youngblood, Picatinny Arsenal; Jesse H. Zabriskie, Bell Aircraft Corporation.

San Francisco Post Hears Maj. Gen. John B. Medaris Speak on Military Power

The San Francisco Post held its spring dinner meeting at the Fairmont Hotel on Friday, May 17th.

Many of the top industrial leaders of the Bay area were on hand to welcome the guest of honor, Maj. Gen. John B. Medaris, Commander, Army Ballistic Mis-

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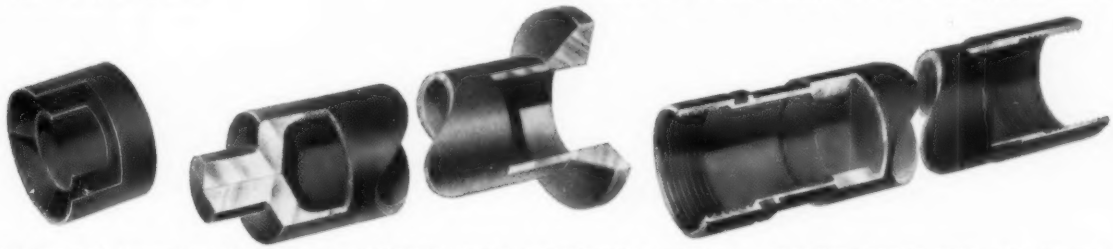

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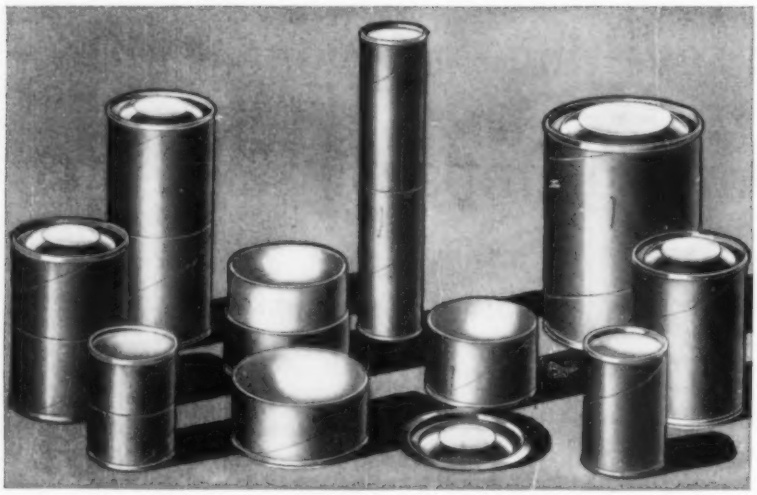

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Made to conform to both grades of MIL-C-3955, Type II, or MIL-C-2439 and other specifications. Produced in diameters from ⅞" and in lengths desired. This container is easily sealed by use of tape to specification JAN-B-127.

SINGLE BODY TYPE

Made to conform to MIL-C-3955, Type I and other specifications. Diameters from 1" and in lengths as required. One metal end seamed on, the other end shipped loose. A machine for attaching the loose end is available on a rental basis.

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sile Agency, Redstone Arsenal, and to commemorate Armed Forces Day. An assembly of 400 members and guests gathered in the Tonga Room to welcome General Medaris.

Post President William E. Butts, who presided at the dinner meeting, presented the special guests including: Maj. Gen. Hugh A. Parker, commander, Western Air Defense Force; Rear Adm. C. G. DeKay, commanding officer, Naval Supply Center, Oakland, Calif.; Brig. Gen. L. L. K. Tarrant, deputy commanding general, Sixth U. S. Army.

Among Post officials were: Dean Witter, director and a regional vice-president of the national Association; Jack L. Ashby, A.O.A. vice-president and a vice-president of Kaiser Steel Corporation; G. M. Greenwood, a member of the Council of the A.O.A. and a vice-president of Rheem Manufacturing Company; J. M. Hait, Post director and the executive vice-president of Food Machinery and Chemical Corporation; William E. Hoard, Post director and regional manager of Western Gear Corporation; Lieut. Gen. LeRoy Lutes, Post director and a vice-president of Mansfield Tire & Rubber Company; Col. Calvin A. Heath, Post secretary-treasurer and deputy chief of the San Francisco Ordnance District.

General Medaris gave a stirring speech, in which he noted the four indispensable components of total power to be: (1) Adequate military power in terms of modern weapons and trained men; (2) Productive power capable of supporting limited to total military requirements and simultaneously supporting the home front; (3) An increasing reservoir of brain power in the form of more scientists and technicians; and (4) Resolute moral power to utilize our strength for the betterment of mankind.

In regard to the long-range missile, General Medaris said it constitutes our mightiest weapon and therefore represents our strongest deterrent against war. However, he added, such a weapon constitutes the gravest threat to our security when in the hands of an unprincipled enemy.

The general described the manner in which missiles and rockets have replaced or are replacing conventional artillery, bombs, and machine guns and greatly extend the striking power of the ground forces. General Medaris reported:

"It is the reality of this which lends impetus to the Army's current effort to place in the Nation's arsenal a fully operational intermediate-range missile at the earliest practicable date. . . . I can assure you that the Army's efforts have been quite successful and that we are on schedule or ahead of schedule in every respect."

Great advances in design . . .

NEED THE ADVANCEMENT IN WEAR RESISTANCE PROVIDED BY FLAME-PLATING BY LINDE

Lockheed's F-104A Starfighter, newest weapon of the Air Force, is the most advanced airplane of its type. To give them the greatest possible resistance to extreme conditions, bearing surfaces *(arrows)* of hot air valves used in a bleed air system of the F-104A are Flame-Plated with tungsten carbide. Flame-Plating provides the wear-resistant coating needed to withstand the high unit loading and temperature extremes jet plane parts undergo.

Stratospheric altitudes . . . supersonic speeds . . . extreme temperatures subject jet plane parts to almost incredible conditions of heat and abrasion. To assure perfect operation in all circumstances, bearings of hot air valves in the Starfighter are Flame-Plated. A tungsten carbide coating, applied by LINDE's unique method, is the only material tried that successfully eliminated galling and provided a low coefficient of friction over the required service life of the part. With the part Flame-Plated, practically no wear occurred. This LINDE process is now a regular production procedure.

Flame-Plating is LINDE's special process for protecting metal parts from wear, abrasion, and fretting corrosion. Tiny particles of tungsten carbide or aluminum oxide are literally *blasted* onto the metal surface. Since the temperature of the part being coated seldom exceeds 400 degrees F., there is little or no risk of changes in its shape or metallurgical properties. Flame-Plated coatings can be applied from .002 to .010 inches thick, and used as coated or finished to 0.5 microinches rms. Practically all metals can be Flame-Plated—aluminum, magnesium, molybdenum, titanium as well as copper and steel.

Your own design may be improved by Flame-Plating. Find out how, by writing for a copy of the booklet "Flame-Plating," F8065. Address Flame-Plating, Dept. OR-7. LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y.

In Canada: Linde Company, Division of Union Carbide Canada Limited.

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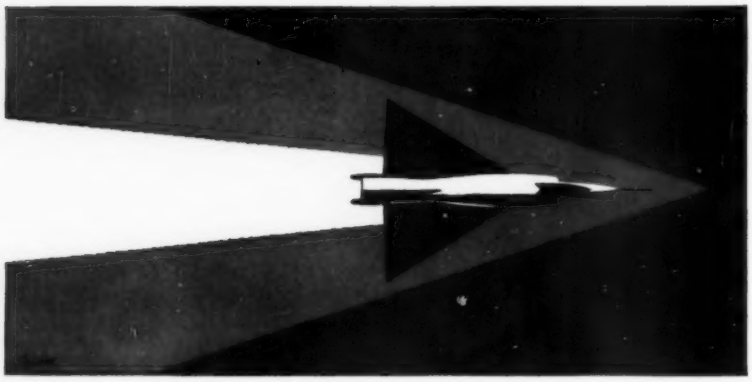
FROM A STEEL TEST TUBE —TOMORROW'S AIRCRAFT!



■ The punishment imposed on air chambers and tunnel walls of the NACA's huge new Langley Aeronautical Laboratory wind tunnel demanded an exhaustive study of all available materials of construction. The requirements: proved reliability and endurance in the face of high pressures and corrosive attack.

Two special duty steels survived that critical examination: for the chambers—Lukens "T-1" brand, with a yield strength of 90,000 psi yet readily weldable; and for the tunnel—Lukens stainless-clad "T-1", a composite of the high and lower alloy content steels permanently bonded into a single steel plate.

The above is just one example of how Lukens broad range of special purpose steels are contributing to the improved design and performance of modern defense equipment. Find out more about them, how they fit your needs. For copies of the informative, illustrated booklets, LUKENS "T-1" STEEL and CLAD STEEL EQUIPMENT, *or* for information concerning your specific problem, address Manager, Marketing Service, 904 Lukens Building, Lukens Steel Company, Coatesville, Pa.

LUKENS ®

Helping industry choose steels that fit the job

Tri-Cities Chapter of the Empire Post Holds Annual Dinner at Vestal, N. Y.

The Tri-Cities Chapter of the Empire Post held its annual dinner meeting on Thursday, March 7th, at Vestal, N. Y. More than seventy-five members and guests attended a reception before the dinner to greet Lieut. Col. John Reid, Deputy Chief of the Rochester Air Procurement District.

John Bouman, Chapter chairman, presided at the dinner meeting where he called upon William Kinnaman, Chapter secretary to read the preamble to the A.O.A. constitution. Boyd Elliot, chairman of the membership committee, gave a brief talk on the advantages of membership in the Association.

Col. W. A. Davis, deputy chief of the Rochester Ordnance District, presented a concise and interesting picture of the operations and responsibility of the district.

Col. Reid spoke on "Guided Missiles and Space Travel." He illustrated his talk with two excellent films on missile and component testing. He discribed the various operational missiles now used in the Air Force, noted briefly the various missiles under development and pointed out how the technical break-throughs in developing missiles have advanced the possibility of successful space travel.

An enthusiastic vote of thanks was tendered to the Marine Corps Reserve group under Captain Gillick who took charge of the movie and slide projection for Colonel Reid's talk.

College R.O.T.C. Units Award A.O.A. Scholarship Keys to Outstanding Ordnance Cadets

Each year the honor Ordnance cadets in the R.O.T.C. units in colleges throughout the country are awarded the American Ordnance Association Scholarship Key and a year's membership in the Association. These awards were made recently at the following institutions:

University of Arizona.—Cadet Lieut. Col. Jerry R. Seiler, Tucson, Ariz., is majoring in chemistry and is a member of Sigma Alpha Epsilon, Bobcats, the Senior Honorary, and Scabbard and Blade.

A. & M. College of Texas.—Cadet Capt. Bobby H. Nelson, Bellare, Tex., is majoring in mechanical engineering and is a member of the Houston A. & M. Club, San Jacinto A. & M. Club, and American Society of Mechanical Engineers. *(Continued on p. 98)*

Will today's defense dollars buy safer air travel tomorrow?

Fabulous Radar—the ever-watchful eye that sees aircraft night and day through rain, fog and snow—continues to unfold new miracles, to build an ever-stronger defense for America. A recent Avco-Crosley contribution to the military is the new height-finder radar, developed in close co-operation with the Rome Air Development Center, Rome, New York.

But there are peacetime benefits, too. Avco-Crosley, for example, has assisted the Air Force Cambridge Research Center in the development of Volscan, a semi-automatic air traffic control system. Already tested by the U. S. Air Force, Volscan has proved its ability to almost triple airport landing capacities . . . to help solve today's mounting air traffic problems.

Such progress leads the way to a completely automatic nationwide air traffic control system. Soon, passenger aircraft may wing coast-to-coast in complete and automatic safety—watched and controlled from the ground.

Thus, as defense dollars preserve the peace, they also help create a world of greater safety. And as Avco-Crosley serves defense, it builds for America's future.

For additional information about Volscan and other Crosley electronics developments, write on your letterhead to: Manager of Electronics System Engineering, Avco-Crosley, 1329 Arlington Street, Cincinnati 25, Ohio.

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defense and industrial products

Lt. General Clarence S. Irvine, Deputy Chief of Staff Materiel, USAF, says:

"The great progress which has been made in the field of avionics has been achieved by close teamwork between the Air Force and private industry. Daily application of new developments continues to contribute mightily to the growth, development and well-being of our nation."

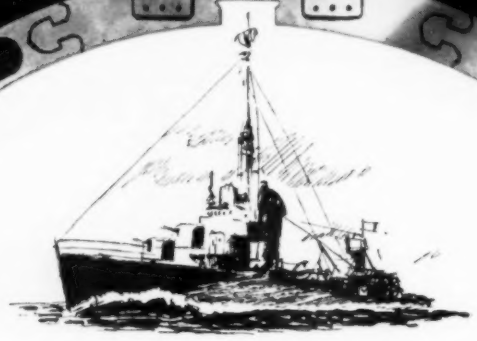
Avco's defense and industrial products combine the scientific and engineering skills, and production facilities of three great divisions of Avco: Crosley; Lycoming; Research and Advanced Development—to produce power plants, electronics, airframe structures, missiles, and precision parts.

TODAY'S MILITARY SERVICES, WITH THEIR TREMENDOUS TECHNOLOGICAL ADVANCES MADE POSSIBLE THROUGH SCIENCE, OFFER A VITAL, REWARDING CAREER.

ANNOUNCEMENT! The new, improved

When Teddy Roosevelt's boys charged up San Juan Hill, they carried their drinking water in canteens of Alcoa® Aluminum. The metal was light, rustproof, durable . . . ideally adapted to the purpose at hand. Those very qualities, along with a host of others, make it an even better ordnance material today.

Alcoa Imagineers Aluminum for Defense



for cutting torpedo tube costs...

INTERLOCKING ALCOA EXTRUDED SHAPES

Torpedo tubes for destroyers—formerly built of riveted plates—now are being made from ingenious 8-part Alcoa interlocking extruded shapes designed by Northern Ordnance, Minneapolis, Minnesota, in conjunction with the Bureau of Ordnance. An improved product that saves time and money has resulted by switching to the new Alcoa extrusions.

The tubes are formed from eight interlocking sections that slide together. Finished diameter is 23½ inches, length is 21 feet. A total of 36 various-shaped voids or holes run the entire length of the tube walls.

Alcoa counsel is readily available to you on making materials of aluminum faster, better and at lowest possible cost. You'll profit from talking over your ordnance production problems with the most experienced company in the field. Write ALUMINUM COMPANY OF AMERICA, 850-G Alcoa Building, Pittsburgh 19, Pa., or contact your nearest Alcoa sales office.

Your Guide to the Best in Aluminum Value

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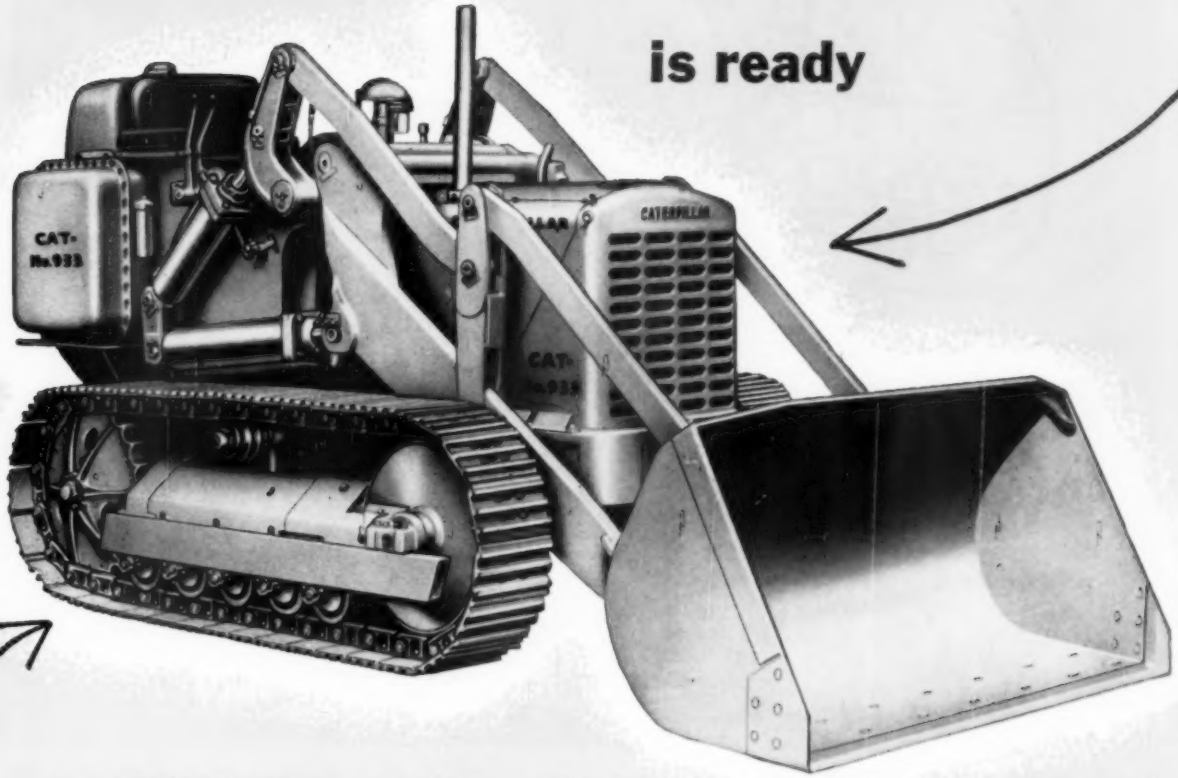
ANNOUNCEMENT! The new, improved

No. 933 (Series E) TRAXCAVATOR*

is ready



with longer life, lower maintenance!

Looks a lot like the popular No. 933 you already know—but there's greater stability, performance and durability built into this new Series E!

Now the rugged CAT* No. 933 Traxcavator includes a new heavy-duty undercarriage with:

- New Rugged Track Roller Frame
- New Solid Sprockets
- New Heavier Idlers
- New Tough Track Rollers

The complete line of Cat-built Traxcavators	No. 977	No. 955	New No. 933 (Series E)
Flywheel HP at sea level	100	70	50
Bucket capacity, cu. yd.	2¼	1½	1
Bucket tip-back at ground level	40°	40°	40°
Bucket tip-back at maximum lift	46½°	47½°	48°
Dumping height (center of hinge pin to ground)	141½"	128"	119 1/16"

The easy operation, the great capacity and the dependable power—these features remain as outstanding as before.

For complete details on this *tough* new Traxcavator, call your Caterpillar Dealer. He'll be glad to give you full information on the complete line of Cat-built Traxcavators. He's the man to remember, too, for expert service and for replacement parts you can trust.

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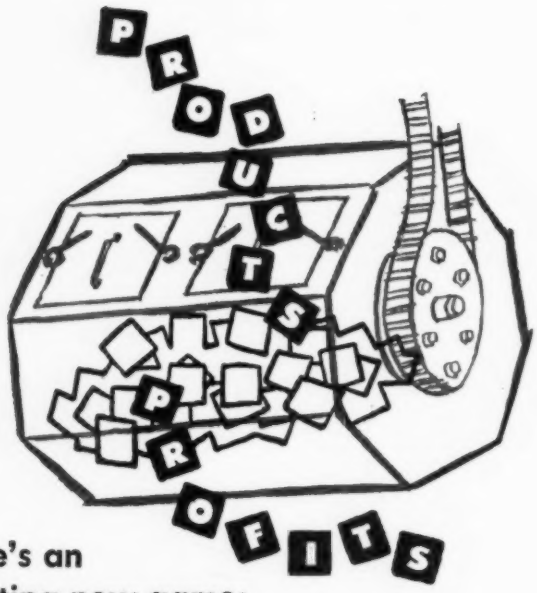
ONE GOAL: To concentrate our capabilities, resources and experience on the design, manufacture, distribution and service of job-tested heavy equipment.



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One of the greatest money-saving opportunities in metal-working lies in the use of barrels to finish parts by the hundreds in place of conventional methods that finish one part at a time.

Barrel finishing makes easy work of many tough jobs of grinding, deburring and buffing by wheel.

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Association Affairs (Contd.)

University of Cincinnati.—Cadet Urban F. Meyer, Jr., Cincinnatti, Ohio, majoring in chemical engineering, was graduated this June.

J. R. Seiler B. H. Nelson

The Citadel.—Cadet Rafael E. Martinez-Boucher, Bronx, N. Y., served in the United States Army for three years, is majoring in political science and is a member of several activities including International Relations Club, Cadet Orphanage Committee, the Association of the United States Army, American Ordnance Association, and Calliopean Literary Society and was selected as a Tentative Distinguished Military Student.

University of Connecticut.—Cadet Lieut. Robert Snow, Hartford, Conn., will graduate in June with a B.S. degree in business administration while majoring in industrial management. He will enter the Ordnance Corps in October for two years of active duty.

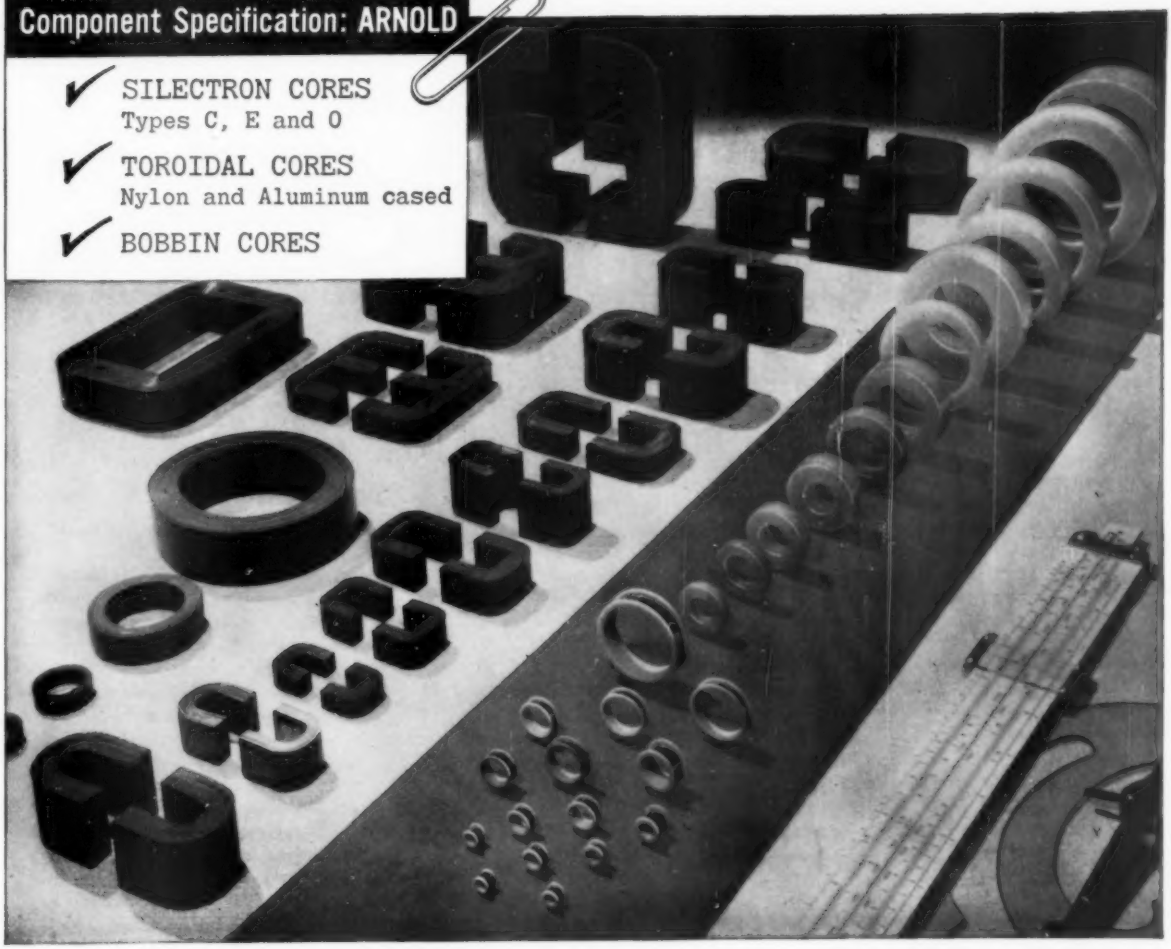
University of Detroit.—Cadet Maj. Eugene Sylvester Johnson, Underwood, N. Dak., majoring in mechanical engineering, was awarded the Westinghouse Scholarship as outstanding student. He is a member of several organizations among them being Pi Tau Sigma, American Society of Mechanical Engineers, and Society of Automotive Engineers.

E. S. Johnson R. E. Martinez-Boucher

Gonzaga University.—Cadet Capt. Raymond G. Anderson, Spokane, Wash., regimental adjutant is majoring in engineering and will graduate and receive a commission in the Ordnance Corps in January 1958. *(Continued on p. 100)*

Component Specification: ARNOLD

- ✔ SILECTRON CORES
  Types C, E and O
- ✔ TOROIDAL CORES
  Nylon and Aluminum cased
- ✔ BOBBIN CORES



The ARNOLD LINE-UP includes the TAPE CORES you need

APPLICATIONS

We'll welcome your inquiries on your Tape Wound Core requirements for Pulse and Power Transformers, 3-Phase Transformers, Magnetic Amplifiers, Current Transformers, Wide-Band Transformers, Non-Linear Retard Coils, Reactors, Coincident Current Matrix Systems, Static Magnetic Memory Elements, Harmonic Generators, etc.

ENGINEERING DATA

For data on the various types of Arnold Tape Cores, write for these Bulletins:

TC-107—*Silectron Cores, Types C, E and O*
TC-101A—*Toroidal Cores, nylon and aluminum cased*
TC-108—*Bobbin Cores*

ADDRESS DEPT. O-77

How to be *sure* of tape core performance and uniformity? Just specify and use *Arnold* Cores in your transformer, magnetic amplifier, reactor and computer assemblies, etc.

Here's why!

To begin with, Arnold is a fully integrated company, controlling every manufacturing step from the raw material to the finished core. Then, modern testing equipment permits 100% inspection of cores before shipment. Finally, you're matching your requirements against the most experienced and complete line of tape cores in the industry. Arnold produces Types C, E and O Silectron cores, nylon and aluminum cased toroidal cores, and bobbin cores to meet whatever your designs may require in tape thickness, material, core size or weight. Wide selections of cores are carried in stock as standard items for quick delivery: both for engineering prototypes to reduce the need for special designs, and for production-quantity shipments to meet your immediate requirements.

Let us help you solve your tape core problems. Check Arnold, too, for your needs in Mo-Permalloy or iron powder cores, and for cast or sintered permanent magnets made from Alnico or other materials.

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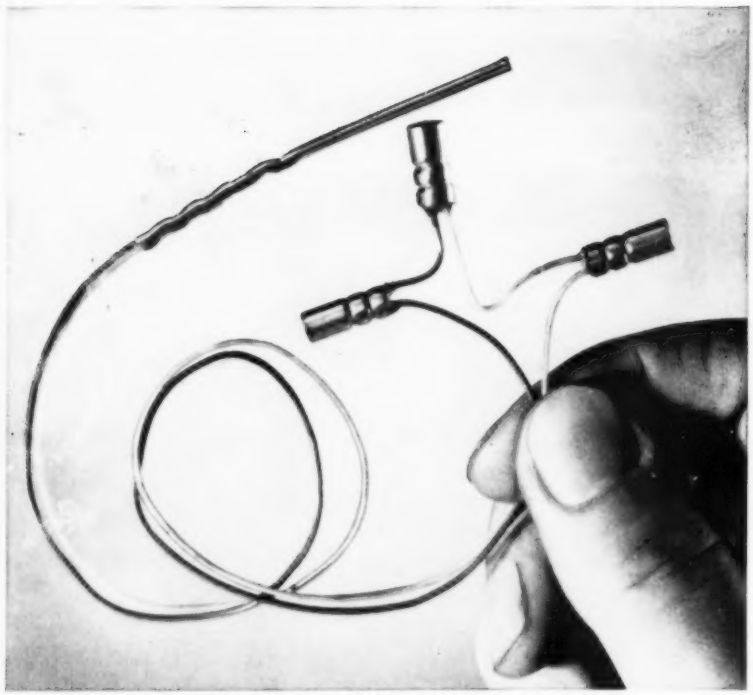
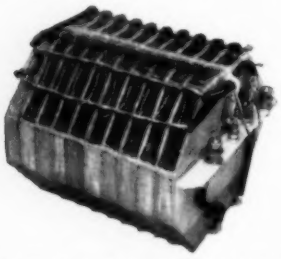


Batteries in "suspended animation" brought to life in one second by Du Pont S-81 Squibs

Using Du Pont S-81 Squibs, underwater missile propulsion batteries are built for prolonged inactive storage by the Exide Industrial Division of the Electric Storage Battery Company.



The electrolyte and plates are held in separate chambers until the battery is needed. The instantaneous squibs are then fired, and within one second the battery delivers full power to the driving motor.

Exide states that only the extreme reliability and uniformity of the Du Pont Squib make this application possible. Batteries can now be held "at the ready" as long as necessary and put into use at a moment's notice.

This application illustrates one of the unusual problems being solved by Du Pont Explosive Specialties such as electric detonators; high temperature aircraft blind expansion rivets; MS delay connectors and a wide variety of squibs.

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Association Affairs (Contd.)

Hofstra College.—Cadet Col. James L. Finger, Jr., Rockville Center, Long Island, N. Y., was graduated June 1957 with a B.S. degree in industrial engineering and received a commission in the Ordnance Corps Reserve. A distinguished military graduate, he has been very active in military and campus affairs.

D. B. Marblestone J. L. Finger, Jr.

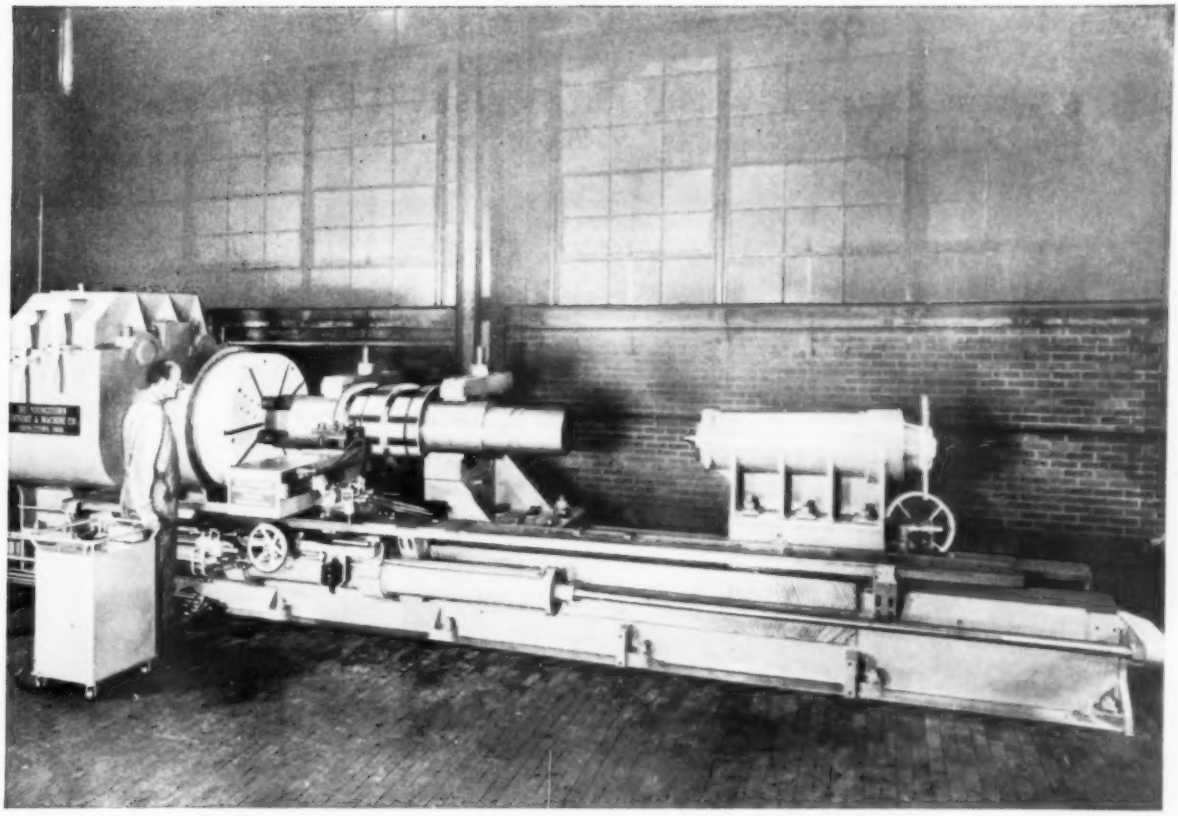
University of Illinois.—Cadet David B. Marblestone, Taylorville, Ill., will graduate in June 1958. He is majoring in mathematics and is a member of the Phalanx, Ordnance Special Drill Team, Student Senate Commission, and United Nations Program General Chairman.

Lafayette College.—Cadet Richard J. Gorman, Schenectady, N. Y., a distinguished military student, is majoring in chemical engineering and is a member of the American Institute of Chemical Engineers. Among his college activities are: Scabbard and Blade Society, Maroon Key Society, and Alumni Scholarship.

Lehigh University.—Cadet Richard M. Billin, Stony Brook, N. Y., was graduated with a metallurgical engineering degree and was commissioned a Reserve Second Lieutenant in the Ordnance Corps. He is a member of Chi Phi, the American Society for Metals, and the Pershing Rifles.

R. A. Snow E. M. Hollandsworth

University of Maine.—Cadet Philip L. Coffin, Pittsfield, Maine, majored in mechanical engineering. He was graduated this June and will serve two years in the Ordnance Corps. He is a member of the American Society of Mechanical Engineers. *(Continued on p. 102)*



New 36" contour roll lathe can turn parts on necks or centers . . . cut with single point carbide tools or with regular roll turning tools. Speeds range from .75 to 53.4 RPM. All heavy cast sections are ductile iron. Built by Youngstown Foundry and Machine Co., Youngstown, Ohio.

Ductile iron specified for heavy castings in new roll turning lathe

Today's machinist demands precision plus ruggedness in a roll turning lathe.

To meet these demands in its new 36" contour model, Youngstown Foundry and Machine turned to ductile cast iron for the lathe's four major castings.

For the face plate . . . ductile iron provided strength, toughness and wear resistance . . .

For the head stock . . . high strength along with good damping capacity . . .

For the tail stock . . . strength and toughness . . . a high modulus of elasticity . . .

For the carriage . . . high rigidity and strength.

Ductile cast iron provided these higher properties plus superior castability and machinability. That's because ductile iron combines certain advantages of steel and gray iron.

What about ductile cast iron for your application?

You may find ductile iron's combination of higher strength levels and good casting and machining characteristics will answer your design needs.

Why not find out how ductile cast iron can improve your product . . . save you production time and money.

Send for your copy of "Ductile Iron: The Cast Iron That Can Be Bent." It's packed with useful data.

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Association Affairs (Contd.)

North Carolina State College.—Cadet Lieut. Col. Joseph E. Settle, Raleigh, N. C., is majoring in industrial engineering and will enter the Ordnance Corps for two years. He is active in Student Government, the College Union, Pershing Rifles, Scabbard and Blade, and the Industrial Engineering Honor Society.

University of Notre Dame.—Cadet Lloyd P. Stauder, Allen Park, Mich., will be commissioned a second lieutenant, Ordnance Corps upon completion of his studies at Notre Dame.

Rutgers University.—Cadet Maj. Michael J. Gyetvay, Woodbridge, N. J., has a B.S. degree in mechanical engineering, was graduated in June 1957 and was on the Dean's Honor List. He is a member of the Scabbard and Blade, Tau Beta Pi, Pi Tau Sigma, and other honorary engineering societies.

R. J. Gorman M. J. Gyetvay

University of Tennessee.—Cadet Capt. James L. Van Horn, is a distinguished military student and has been selected for commissioning in the Ordnance Corps.

Virginia Polytechnic Institute.—Cadet Maj. Edgar M. Hollandsworth, Bassett, Va., is majoring in electrical engineering and has been awarded the Distinguished Military Student's Badge, Pershing Rifles' Award, and is a member of Eta Kappa Nu, Tau Beta Pi, Society of Scabbard and Blade, and several honorary societies.

• **WILLIAM G. SKELLY**, chairman of the board of the Skelly Oil Company, died in Tulsa, Okla., on April 11, 1957. He was a life member of the Association and a leader in the founding of the Mid-Continent Post.

He served in the Spanish American War, and settled in Tulsa in 1913 where he had been active in the natural gas and oil business of Oklahoma since that time. As president of his company until last year, he was one of the leading independent operators in the midcontinent oil field. *(Continued on p. 101)*

From the tick of a Wristwatch

to the roar of a Guided Missile

precision operation depends upon

Hunter Douglas Aluminum Cold Forgings!

A question frequently asked by designers is . . . "How small or how large a part can you economically cold forge?"

Out of thousands of Hunter Douglas production items, at one end of the scale is the tiny wristwatch bezel case. Weighing only a hundredth part of a pound, it is cold forged from high purity aluminum, complete with band attachment lugs. Wear properties are superior to gold and gold anodizing imparts a beautiful and lasting finish.

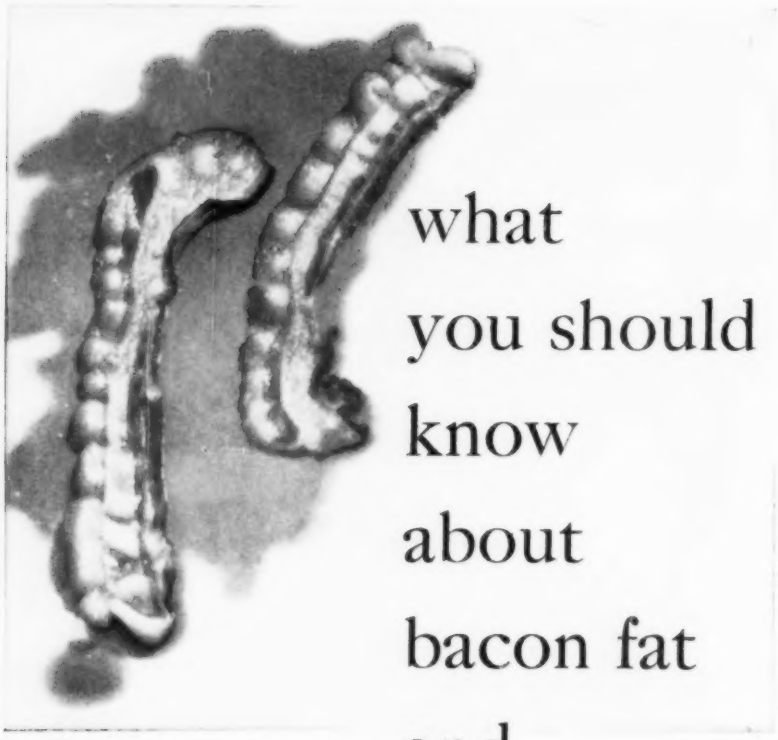
Typical of the largest pieces cold forged to date are aluminum alloy motor tubes. Hunter Douglas supplies these as prime contractors to the U. S. Navy for use in the SIDEWINDER missiles, as well as for the new "ZUNI" rocket. Some rocket tubes measure over 6 feet in length.

SO MUCH FOR SIZE, BUT HOW ABOUT ACCURACY? The watch case speaks for itself, but tolerances of the rocket motor tubes are even more exceptional for their size . . . straightness to .020" TIR, I.D.'s to ±.006" and uniformity of wall thickness to ±.0015". Other tubes are produced with walls as thin as .015", some as thick as .250" or more. *Typical concentricity of these is within .001" with wall tolerances of .002" and straightness in the range of .005"/ft.—in any alloy!*

Between these size extremes lies a vast number of hollow components which can be economically cold forged—with almost complete elimination of, or greatly reduced, machining costs. If you require parts having *superior strength, zero draft, smooth finishes* and *mechanical properties comparable to hot forgings* you'll find an answer in Hunter Douglas Cold Forgings . . . now available in *high strength aluminum alloys, and experimentally in oxygen-free copper, zirconium, magnesium and many steels!* Ask us for recommendations.

Hunter Douglas Aluminum

Division of
BRIDGEPORT BRASS COMPANY
Dept. O-7, Riverside, California, Telephone OVerland 3-3030



what you should know about bacon fat and Albanene®

Here's the buying information you should have to get the *best* value when you buy tracing paper.

1. The usual way of "transparentizing" tracing papers is with waxes or mineral oils—much the way bacon fat makes a paper towel transparent. Eventually, these oily fluids "leak" out—leaving the paper opaque and useless for reproductions.

Result: Valuable drawings on ordinary tracing papers eventually become yellow or brittle—lose their reproduction qualities. And, these days, replacements often cost twice as much as the originals.

2. The K & E way—Albanene tracing paper is made transparent with an inert synthetic resin which is chemically stable . . . can't leak out—ever!

Result: Albanene stays transparent . . . stays strong . . . protects every nickel you invest in time and talent working on it.

Important: During manufacture, constant testing *guarantees* uniformity as well as pencil taking and erasing qualities. The very qualities that have made Albanene—America's best selling tracing paper.

Try Albanene Today . . . it's available in 3 weights and in rolls, sheets or pads. Try it now . . . it's the best value you can buy!

89 YEARS OF LEADERSHIP

In equipment and materials for drafting, surveying, reproduction and optical tooling . . . in slide rules and measuring tapes.

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Association Affairs (Contd.)

Mr. Skelly had many other business interests including directorships in insurance and banking companies.

He served many years as president of the International Exposition and Congress in Tulsa, and in 1929 was voted that city's most useful citizen.

During World War II, Mr. Skelly was instrumental in spurring the production of midcontinent industries for the war effort. Through this interest he became a devoted adherent of the A.O.A. and its aims and purposes.

• **CAPT. CHARLES H. ANDERSON, JR.**, U.S.N., Ret., died at his home in Pittsfield, Mass., on March 29, 1957.

Captain Anderson, a member of the American Ordnance Association, retired in July 1955 after a distinguished career of thirty years in the United States Navy. Since his retirement he had been a specialist in advanced engineering at the Pittsfield Branch of the General Electric Company.

He was an outstanding naval ordnance expert specializing in explosives. After being graduated from the Naval Academy in 1925 and a tour at sea he undertook postgraduate work in ordnance engineering from 1930 to 1933, receiving an M.S. degree from the University of Michigan.

During World War II he served in the Bureau of Ordnance as chief of the Research and Development Section for Naval Guns and Mounts. At sea during the war he commanded the transport COLLINGSWORTH in the Pacific.

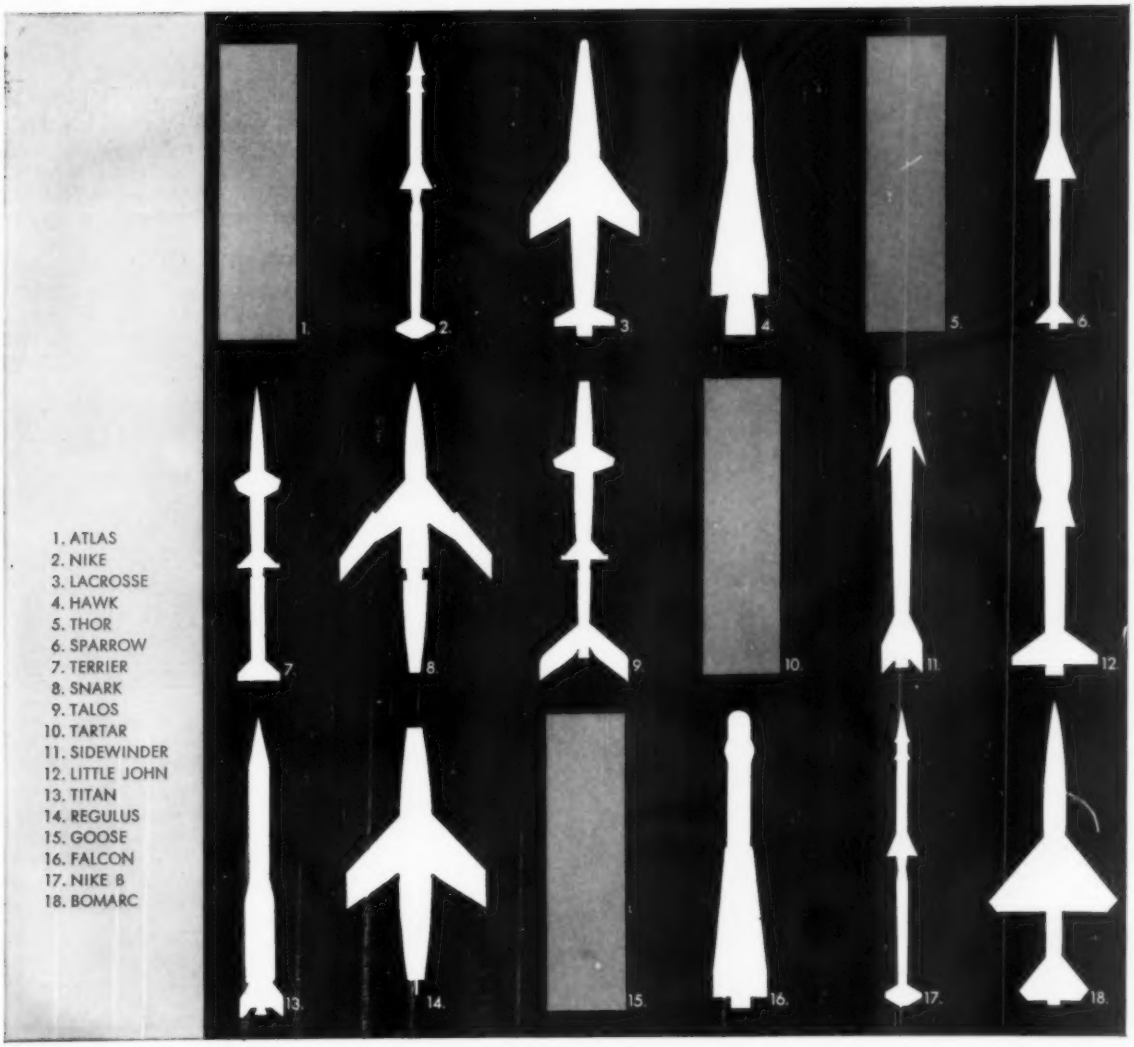
In the years before his retirement, Captain Anderson served in the Office of the Chief of Naval Operations and on staffs at sea in Cruiser Division 3 and in the Joint Task Force on Atomic Bomb Tests at Eniwetok. He also commanded the experimental gunnery ship MISSISSIPPI. His last assignment was supervising inspector of naval material in the eastern Pennsylvania area where he became well known to many of the members of the Ordnance Association.

• **HENRY A. FIELD**, a banking and insurance executive, died in Springfield, Mass., on February 28, 1957. He was a life member of the Association.

Mr. Field was a native of Massachusetts and graduated in 1887 from Deerfield Academy. In 1898 he was district manager of the Vacuum Oil Company where he remained until he entered the insurance business ten years later.

Mr. Feld was active in many civic programs and in 1945 was awarded the William Pynchon Medal for his outstanding contributions to the welfare of his country.

In addition to insurance affairs, Mr. Field was active in banking and transportation organizations as well as civic groups.



Pick a program .. you'll find

AMF has missile experience you can use

In program after program, including each of those above, AMF has played or is playing an important role. A component supplier in some, a system developer in others, AMF knows the missile business first-hand. • AMF contributions to the nation's missile programs include test and check-out systems, handling and launching equipment, on-site missile storage facilities, accessory power supplies. • See for yourself why AMF's widely diversified background plus its up-to-the-minute missile activities add up to "experience you can use".

Research, Development, Production in these fields:
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- *Ballistics*
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- *Auxiliary Power Supplies*
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Green Core *Super* Cloth Rap, Heavyweight, has a greaseproof film on cloth backing, coated on both sides with compounded, microcrystalline wax. The material is particularly recommended for Methods 1, 1A-1 and 1A-2 under MIL-P-116. Qualified Products List Numbers will be furnished upon request.

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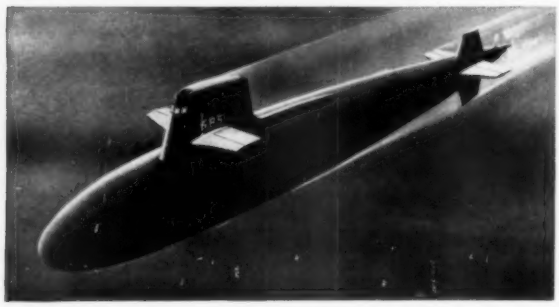
NEW DEVELOPMENTS

NEW ATOMIC SUBMARINE

Bow diving planes, normally located on the hull, will be attached to the conning tower of the Navy's newest nuclear submarine, SKIPJACK, the first atomic sub designed from the keel up for continuous underwater operations. The submersible is



Sketch of the SKIPJACK shows position of bow planes.

now being built by General Dynamics Corporation's Electric Boat Division in Groton, Conn. The newly positioned diving planes will contribute to the SKIPJACK's stealth and improve her maneuverability. Another feature which leans toward airplane design is the one-man "joy-stick" control system. The Navy has ordered six additional subs of the SKIPJACK class, all with single propellers and blimp-shaped hulls for greater submerged speeds.

HELICOPTER ARMAMENT

A new type of airborne armament has been designed to give helicopters defensive protection in battle. The armament, which can be attached easily to any type helicopter, is comprised of two kits containing caliber .308 machine guns and small rockets.

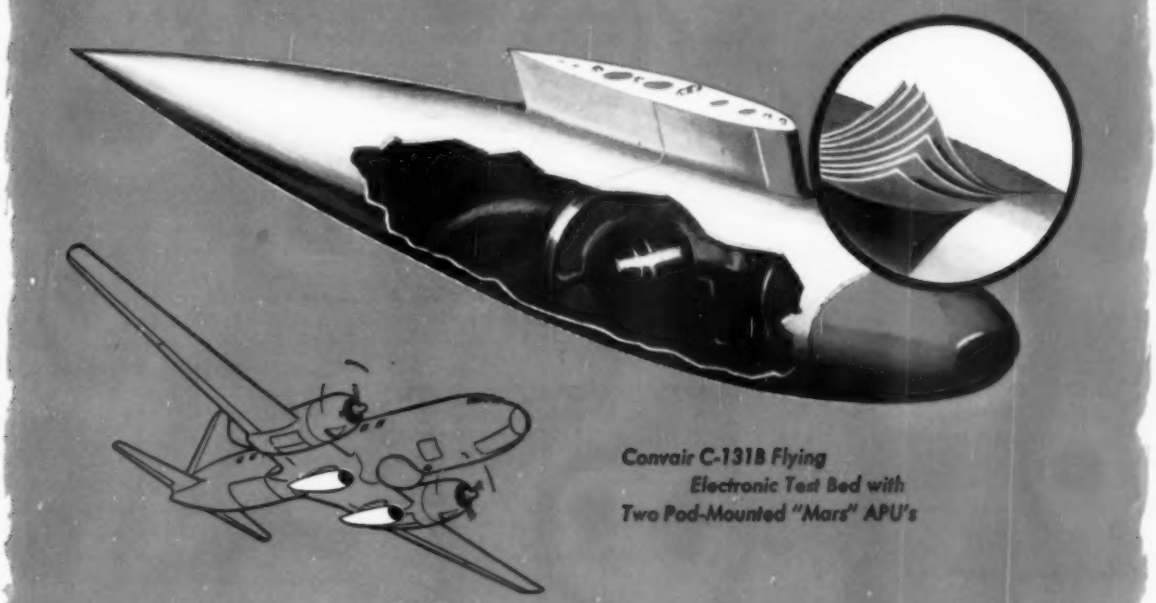
Developed by aircraft armament engineers in General Electric's Missile and Ordnance Systems Department, the new helicopter weapons are called ground fire suppression kits. Their primary purpose is to protect assault troops in battle areas from harrassing enemy fire. One kit consists of two caliber .308 machine guns. Two of these kits can be readily attached to both sides of a helicopter and controlled by a hand-grip firing mechanism within the helicopter cockpit. The other kit is a "fixed" unit which also contains two caliber .308 machine guns and, in addition, carries eight 3.5-inch rockets. Each kit is so constructed that assault troops could, if necessary, remove the machine guns and ammunition from their mountings and use them as regular field weapons.

BULLPUP MISSILE

A new Navy air-to-surface missile, the Bullpup, is designed to be launched from any position outside the effective range of enemy high-volume ground fire and provide sufficient accuracy to destroy small targets without excessive sorties and expenditures of large quantities of bombs and rockets. The basic concept of this missile system was conceived during the Korean war when pilots were particularly harassed by enemy small-arms and automatic ground fire. Bullpup is expected to provide light attack aircraft with a significantly greater attack capability against pillboxes, tanks, truck convoys, marshaling yards, and other targets.

(*Continued on p. 108*)

DOING JOBS EVERY DAY THAT METALS ALONE CAN'T DO



Convair C-131B Flying Electronic Test Bed with Two Pod-Mounted "Mars" APU's

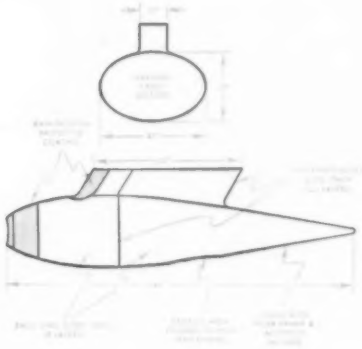
BUILT TO STAND PUNISHMENT

Using tough, lightweight CONOLON 506

Solar Aircraft Company engineers were faced with a problem... how to aerodynamically enclose the "Mars" gas-turbine engine auxiliary electric-power generating units (APU's) to be mounted on Convair C-131B aircraft. The C-131B's so fitted were to be used for the in-flight testing of advanced airborne electronic equipment.

Housing the APU's required an aerodynamic pod built in two parts with multiple compound curvatures and drastically sharp bends. The materials problem presented was complex. The material selected had to withstand... temperatures of 400 F or even higher... contact with a special synthetic lube fluid for the turbine engine... high lead content exhaust fumes... ground handling abuses... aerodynamic wind loads... and severe abrasion because the pod was to be mounted only 12 inches above the runway.

The material that satisfied all these requirements? Conolon 506! Pods were assembled of this highly-formable Conolon 506 on low cost tooling and weighed less than 83 pounds each... another illustration of how Narmco's high performance products are *doing jobs every day that metals alone can't do.*



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New Developments (Contd.)

NAVY MISSILE RADAR

A class of super-radars, SPQ-5, now in service with the fleet for guidance of its Terrier missiles, has been disclosed by the Navy. The massive, turretlike antennae for the new radars have radically changed the contours of the Nation's fighting ships.

Developed for the Navy by Sperry Gyroscope Company, Great Neck, N. Y., the long-range, high-altitude, missile-guidance radar systems provide the Navy's newest missile ships with added punch and power through increased accuracy and range.

The new super-radars are a part of the Navy's program directed toward providing the fleet with highly reliable missiles to combat supersonic jet aircraft. The two SPQ-5 systems on board the U.S.S. CANBERRA combine many automatic radar functions in each unit. Either system can control the missiles from a single launcher or battery which fires the Terrier missile, or both radars can track different target groups simultaneously.

BOMARC MISSILE

The Air Force recently awarded a contract to the Boeing Airplane Company of Seattle, Wash., for production models of the IM-99 Bomarc pilotless interceptor. Designed to operate at extreme altitudes and supersonic speeds, the IM-99 has a long-range capability and will be used by the Air Defense Command in its growing network of air-defense weapons.

Range of the missile is such that it can shoot down enemy bombers at a far greater distance than any other missile presently in use in air defense. Bomarc is launched vertically into the air by a liquid-fuel rocket motor. Cruising flight is sustained with twin ramjet engines slung on struts beneath the slim, cylindrical body of the missile. The latest electronic systems available control the weapon.

JET FIGHTER REFUELING

First successful in-flight refueling of one supersonic jet fighter by another was completed recently by two North American F-100D Super Sabres. Under this "buddy system," one fighter trails a hose and drogue from an external pod carried under one wing and pumps fuel from its tanks to another fighter. After the fuel transfer, the airplane acting as a tanker can return to its base while the other fighter can fly on to a distant target.

F-100 Super Sabres refueling in flight.

This permits two fighters to fly out together and refuel at their normal high speeds and altitude. Thus the fighter which is to continue on avoids the problem of hunting for the tanker and also avoids the loss of range encountered when he must come down to a larger tanker's lower speed and altitude.

LEAK DETECTOR

A newly improved electronic leak detector—so sensitive it can detect one part of helium in two million parts of air—has been announced by General Electric's Instrument Department. Based on an original development for the wartime atomic-energy program, the redesigned mass spectrometer leak detector features extreme sensitivity, fast response, and high resolution.

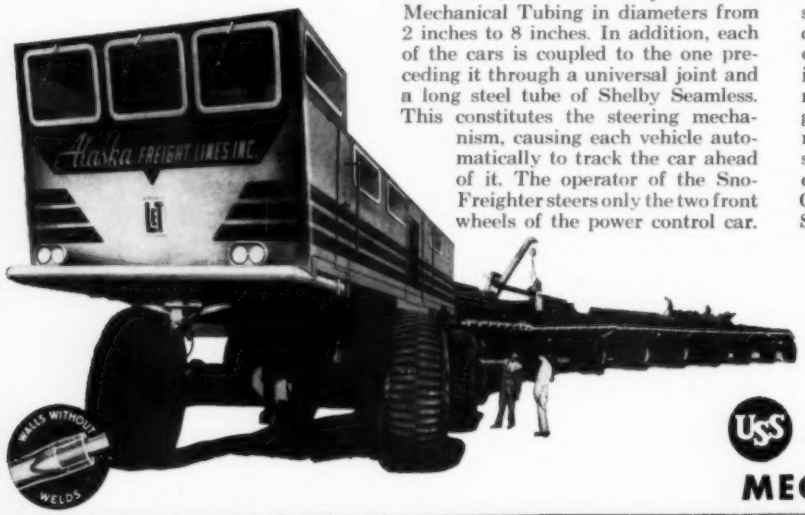
Ten times more sensitive than its predecessor, the new M-2 leak detector finds and locates leaks in vacuum or pressure systems and can readily detect a leak rate of 1×10^{-10} standard cubic centimeters of air per second—a rate so small that it would take more than 5,000 years for one cubic centimeter of air at atmospheric pressure to leak into an evacuated vessel. (*Continued on p. 110*)

Giant LeTourneau Sno-Freighter built on rugged backbone
OF SHELBY SEAMLESS TUBING

The LeTourneau Sno-Freighter is a huge six-section cargo carrier specifically designed to travel over ice, frozen or compacted snow, bull-dozed trails, or rough brush land. It is presently in active use hauling fuel and other strategic materials to radar stations along the Arctic Coast.

The Sno-Freighter "train" consists of a power control car and five cargo cars, each with a capacity of 25 tons. All of the Sno-Freighter's car frames are constructed of Shelby Seamless Mechanical Tubing in diameters from 2 inches to 8 inches. In addition, each of the cars is coupled to the one preceding it through a universal joint and a long steel tube of Shelby Seamless. This constitutes the steering mechanism, causing each vehicle automatically to track the car ahead of it. The operator of the Sno-Freighter steers only the two front wheels of the power control car.

There are many good reasons why Shelby Seamless Mechanical Tubing was chosen for the supporting framework of this magnificent mechanical marvel. Primarily, it offers the ultimate in strength and rigidity in proportion to its size and weight. Secondly, it is shock-absorbent, uniform throughout, dimensionally accurate, and possesses excellent machining and superior welding properties. It is produced under rigid standards, and is available in a generous range of diameters, wall thicknesses, various shapes and steel analyses. And it can be fitted to your specifications, regardless of what they are. Our engineers will help you adapt Shelby Seamless to your requirements.

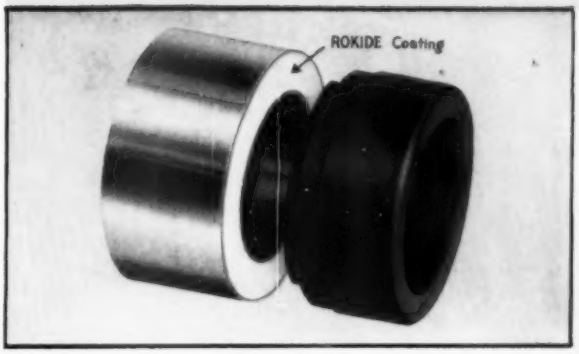


NATIONAL TUBE DIVISION
UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
(Tubing Specialties)
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

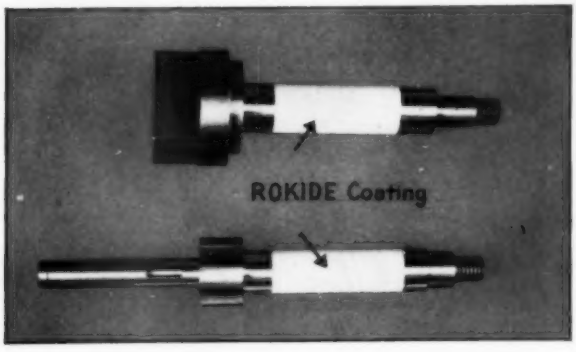
USS SHELBY SEAMLESS MECHANICAL TUBING

UNITED STATES STEEL

ROKIDE* Spray Coatings Add Life to Many Different Parts



In the upper photo courtesy of the Durametallic Corporation, the arrow shows where ROKIDE coating is applied to Dura Seals developed by this organization for sealing many chemicals. On the ring at left, the ROKIDE coating provides ideal mating with the carbon gland insert at right. This assures a tight, long wearing seal. In the photo below, ROKIDE coatings, indicated by arrows, provide equally valuable wear resistance for parts such as metal shafts.



ROKIDE coatings can be applied to parts of a wide variety of shapes and sizes. These new coatings are produced by heating the end of a solid rod and projecting the molten particles at a high velocity against a prepared surface where they adhere and solidify. Already in use for many military and commercial applications, ROKIDE coatings are also being tested on many other jobs.

Norton ROKIDE spray coatings are hard, adherent crystalline refractory oxides. They protect a variety of underlying materials, particularly metals, with benefits including:

Great resistance to wear, thermal shock and corrosion . . . low friction surface . . . high melting point . . . excellent mechanical strength . . . dimensional stability . . . relative chemical inertness . . . perfect mating for carbons.

The Three Types

ROKIDE "A" aluminum oxide, ROKIDE "ZS" zirconium silicate and ROKIDE "Z" zirconium oxide have proved successful for many uses. For example, in applications involving electrical insulation, electronics, bearing surfaces, erosion protection, corrosion resistance, chemical barriers, material upgrading, surface catalyst activity, general wear resistance and altering emissivity and characteristics of surfaces.

Facilities for applying ROKIDE coatings are maintained at Norton Company, Worcester, Mass., and at its plant 2555 Lafayette Street, Santa Clara, Cal. For the latest ROKIDE Bulletin, write to NORTON COMPANY, 746 New Bond St., Worcester, Mass.

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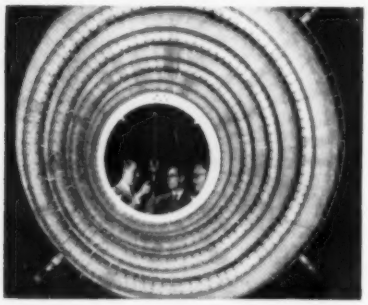
*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

New Developments (Contd.)

The device to be leak-tested is evacuated and connected to the leak detector. A small jet of tracer gas (usually helium) is then sprayed over the surfaces of the equipment under test. If a leak is present, the sensitive instrument locates the leak which is indicated on the operator's control panel.

MISSILE TOASTER

A giant "toaster" that could brown 7,000 slices of bread in a few seconds is helping Chrysler Corporation engineers determine the effect of air friction on the nose of a giant missile when it reënters the earth's atmosphere near the end of its flight.



"Toaster" has 1,000 infrared lamps.

The toaster is a funnel-shaped testing apparatus inside of which are arranged banks of more than 1,000 quartz infrared lamps capable of creating temperatures in thousands of degrees Fahrenheit with almost no warm-up period.

The nose of a big Redstone missile is wheeled into the toaster for a test. After the missile nose is positioned in the heat test chamber hydraulic jacks are placed to apply the stresses expected in reëntry.

A switch is thrown and the interior of the toaster flashes alive with intense heat. For approximately thirty seconds the nose is subjected to the same punishment it would meet when it roars back into earth's atmosphere at supersonic speed. For a single test the toaster requires approximately 3,600,000 watts of electrical power, enough to supply the maximum demand of 5,600 homes.

NEW SUPPORT CENTER

A new vehicle-mounted Army coördinating center has been developed which will give commanders in nuclear-age combat instant control over dispersed tactical support elements. Called the Tactical Support Center (TSC) the system provides a means by which the army commander welds his highly mobile support forces into a coördinated, power-packed team.

The TSC is housed in thirteen vans and trucks with additional tentage carried in the vans. Specially designed cable plugs are built into each of the vans for rapid interconnection. The center is organized into five major organizational sections: The control center, which is the heart of the operation and headquarters for the TSC director; the direct-support aviation section; the electronic-warfare section; the fire-support or artillery section; and the air-defense section.

The TSC concept requires the use of nearly every available communications medium, including radio, teletypewriter, telephone, television, and facsimile, and has its own power generators.

NEW TURBOCATAPULT

A revolutionary new method of launching high-speed aircraft from short airfields has been disclosed by the Navy. The new system was introduced at All American Engineering Company's test facilities in Georgetown, Del., where piston-engine and jet aircraft have been launched from the world's first turbine-powered catapult. The system has been developed primarily for use by Marine aviation in the early stages of amphibious operations.

With it, Navy aircraft boosted by the turbocatapult have been launched into the air in less than one-fifth of their normal take-off runs. The new device is only one-fifth the weight of a comparable steam catapult.

Powered by six jet engines, the turbocatapult develops 60,000 horsepower but can be dismantled with comparative ease and transported by air to fields where it is needed.

Bidirectional in design, the six jet engines are arranged in a circle with the exhaust gases flowing into central launching turbines that drive a drum cable system mounted on the same driveshaft. With the jet engines set at a predetermined r.p.m., the flow gate is actuated, diverting the mass flow of powerful exhaust gases into one of the launching turbines which supplies power to the aircraft through the drum cable system. This makes it possible for the aircraft to attain flying speed long before it could be reached utilizing its own power.

RESEARCH AIRCRAFT

The Air Force has announced progress in development of a new research aircraft. Wind-tunnel tests are nearing completion, and fabrication of the X-15 rocket-powered research airplane, scheduled to fly higher and faster than any other manned aircraft, has begun at the Los Angeles plant of North American Aviation, Inc. Development of the X-15's liquid-propellant rocket engine is underway by Reaction Motors, Inc., Denville, N. J.

Although specifications are classified, the engine's thrust will be greater than the thrust rating of the Air Force X-1 and X-2 series aircraft which Air Force pilots have flown at speeds of more than 1,650 miles an hour and altitudes of 90,000 feet or more. New design techniques have

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TACAN is the most advanced aircraft navigation system yet developed . . . and Hoffman makes the complete airborne portion of the TACAN-VORTAC systems. Hoffman has also developed the highly efficient HLI-103 Beacon Simulator to bench-test airborne equipment for TACAN-VORTAC UNITS. Other navigation equipment under development at Hoffman includes long range airborne radar direction finding and automatic dead reckoning systems.

In research, development and production in the science of military and commercial electronics, exciting things continue to happen at Hoffman.

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Significant new developments at Hoffman in the fields of navigation, VLF, HF, VHF, UHF, radar, ECM, weapons systems and semiconductors have created important positions for scientists and engineers of high calibre. Please address inquiries to Chief Engineer.

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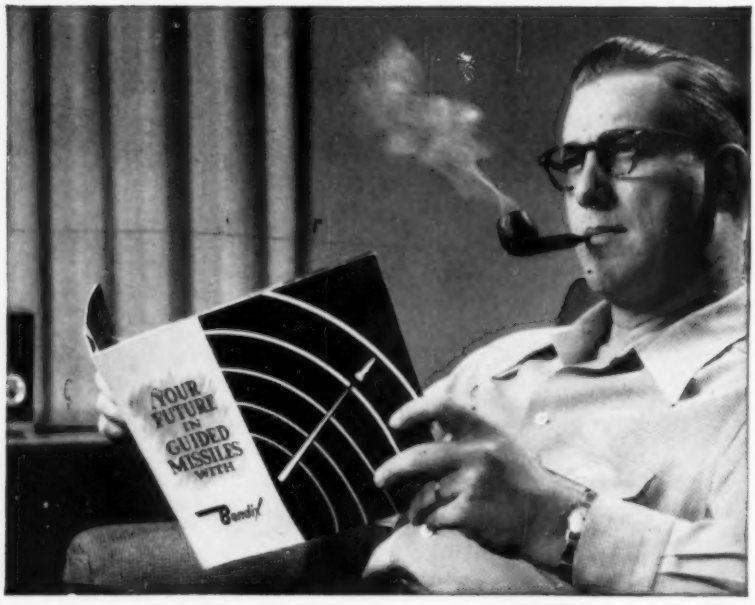

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TROPOSPHERIC SCATTER

"Tropospheric scatter," discovered by Radio Engineering Laboratories, Inc., is a new system of long-distance static-free radio communication which operates with virtually one hundred per cent dependability under weather and ground conditions that render other forms of long-distance communication inoperable, unreliable, or impossible.

The 60-foot White Alice antenna for sending radio telephone and teletype messages.

Current projects of the Laboratories include multimillion dollar contracts for the radio transmission equipment for the "White Alice" project in Alaska, largest troposcatter system yet conceived; the troposcatter network linking mainland defense posts with the "Texas Towers" off the northeastern coast; and the 1,500-mile system known as "Pole Vault" which connects Newfoundland, Baffin Island, and Greenland.

4-ROTOR HELICOPTER

A contract has been awarded to Convertawings, Inc., Amityville, N. Y., by the Department of the Army for research on the 4-rotor helicopter concept.

In the 4-rotor helicopter, commonly called a "quadrotor," four smaller rotors replace the one or two large rotors normally used to lift a helicopter. The quadrotor concept, by using small rotors and simpler rotor hubs, is designed to permit a more economical vehicle than is required when the same load is lifted by a single-rotor or two-rotor helicopter.

The Army contract will cover engineering studies and research testing relating to application of the configuration to future Army craft.

The quadrotor configuration may permit easier loading since it will not require the careful positioning of loads required for current helicopters. Greater and more rapid response to movement of the pilot's controls is another advantage claimed for the quadrotor configuration.

A low, powerful-looking silhouette moves swiftly onto the field, spits a few rounds of .50-caliber tracers seeking its target—then lets loose a terrible salvo from six big rifles. Before you can get a good look at it, the thing whirls and vanishes.

The name is ONTOS—a Greek word meaning "the thing." Based on a new concept in armored warfare, ONTOS was developed by Allis-Chalmers for Army Ordnance and is now being produced for the Marine Corps.

Mounting six 106-mm recoilless rifles, the deadly vehicle also carries four .50-caliber spotting rifles and a .30-caliber machine gun. The rifles can be step-fired in salvos of two, fired individually or in a single knockout salvo of six. A "hit-and-run" weapon, ONTOS depends for its punch on quick and accurate firing of its multiple guns, plus its amazing maneuverability on any terrain. ALLIS-CHALMERS, GENERAL OFFICES, MILWAUKEE 1, WISCONSIN.

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ARMAMENT ELECTRONICS

Dr. W. S. Carlson

IN the year 1714 a commission "for the discovery of longitude at sea" was established in Great Britain. The commission undertook to encourage advances in the art of navigation by supporting experimentation and by making monetary awards to inventors. Before its activities were terminated in 1828, the commission had disbursed over £100,000, including the sum of £20,000 awarded to John Harrison for his marine chronometer. Prior to the advent of wireless telegraphy, the accuracy with which longitude could be ascertained at sea from celestial observations depended largely on the accuracy of the ship's chronometer.

Modern radio aids to navigation, such as Decca and Loran, enable position finding to be accomplished without recourse to celestial observation. Although not dependent on the marine chronometer, these techniques do require precise measurement of time intervals. Refinement of frequency standards is therefore a matter of military interest.

Recent developments based on applications of atomic and molecular resonance phenomena in the microwave spectrum provide radio-frequency standards of the highest precision yet attained. Stability to 5 parts in 10^{10}, with no secular drift in frequency, is claimed for a cesium resonance controlled oscillator now available commercially.

The atomic regulator incorporated in this apparatus consists essentially of an evacuated tube about 5 feet long with a cesium reservoir at one end and a detector at the other. Beam control elements in the tube consist of an r-f structure which serves as the interaction space and two deflection magnets, one at each end of the r-f cavity. Pole pieces of the deflection magnets are designed to establish a strong gradient of magnetic field intensity across the tube. This is accomplished by making the pole face areas unequal, which results in unequal flux densities.

In order to picture events taking place in the beam tube, certain properties of a bar magnet may be attributed to the cesium atom. As with all the alkali metals, electronic angular momentum is quantized at $J = \frac{1}{2}$. The corresponding magnetic states $m_J = \pm\frac{1}{2}$, differing only in sign, are equally probable. When cesium atoms effusing from the source at thermal velocities reach the first deflection stage, the beam is resolved into two components. The states $m_J = \pm\frac{1}{2}$ are deviated in opposite directions in moving through the nonuniform magnetic field. A relatively weak uniform field is maintained across the r-f region to preserve space quantization.

After passing through the cavity, the divergent beam encounters a second deflection field. Atoms which have retained their initial magnetic orientation undergo further deviation from the beam axis. Atoms in which reversal of magnetic orientation has been induced are deviated back toward the axis. Collimating apertures in the beam tube are arranged in such a way that only atoms undergoing no net deviation reach the detector.

The rate at which cesium atoms impinge on the detector is therefore a measure of the rate at which reversals of atomic magnetic moment are taking place under the influence of the r-f field. Transitions are induced by exciting the cavity at an appropriate frequency. For transition between any states (F_1, m_1) and (F_2, m_2) the excitation frequency and energy difference must satisfy the resonance condition $f = 1/h \mid E_2 - E_1 \mid$. Moreover, reversal of the magnetic moment must be associated with the transition for operation of the detector. The $(4, 0) - (3, 0)$ transition of Cs^{133} which occurs at $f = 9192.632$ mc. meets these requirements.

THE resonance frequency is almost independent of the reference field maintained across the r-f cavity. At 0.1 gauss, field strength constancy within 10 per cent is adequate for frequency stabilization to 1 part in 10^{10}. Field independence of the transition has important practical implications. If frequency stability required close control of the weak magnetic field, shielding might well present an intractable problem.

Because the beam consists of neutral atoms rather than ions, the flow does not represent a current. To obtain a signal the collimated beam is directed at a heated tungsten or platinum ribbon. Cesium atoms adsorbed on the surface of the filament are subsequently released by thermionic emission. The positive ion is drawn to the collector cathode of an electrostatic secondary emission multiplier. Output of the multiplier is used to control the frequency of the master oscillator.

External output of the cesium clock is taken from a 5-mc. crystal oscillator. Frequency of this oscillator is automatically

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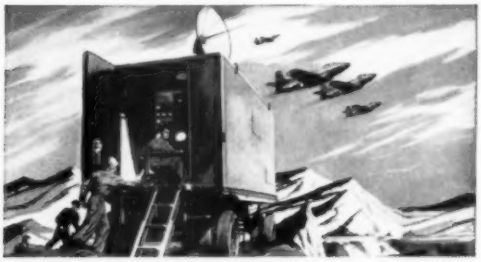

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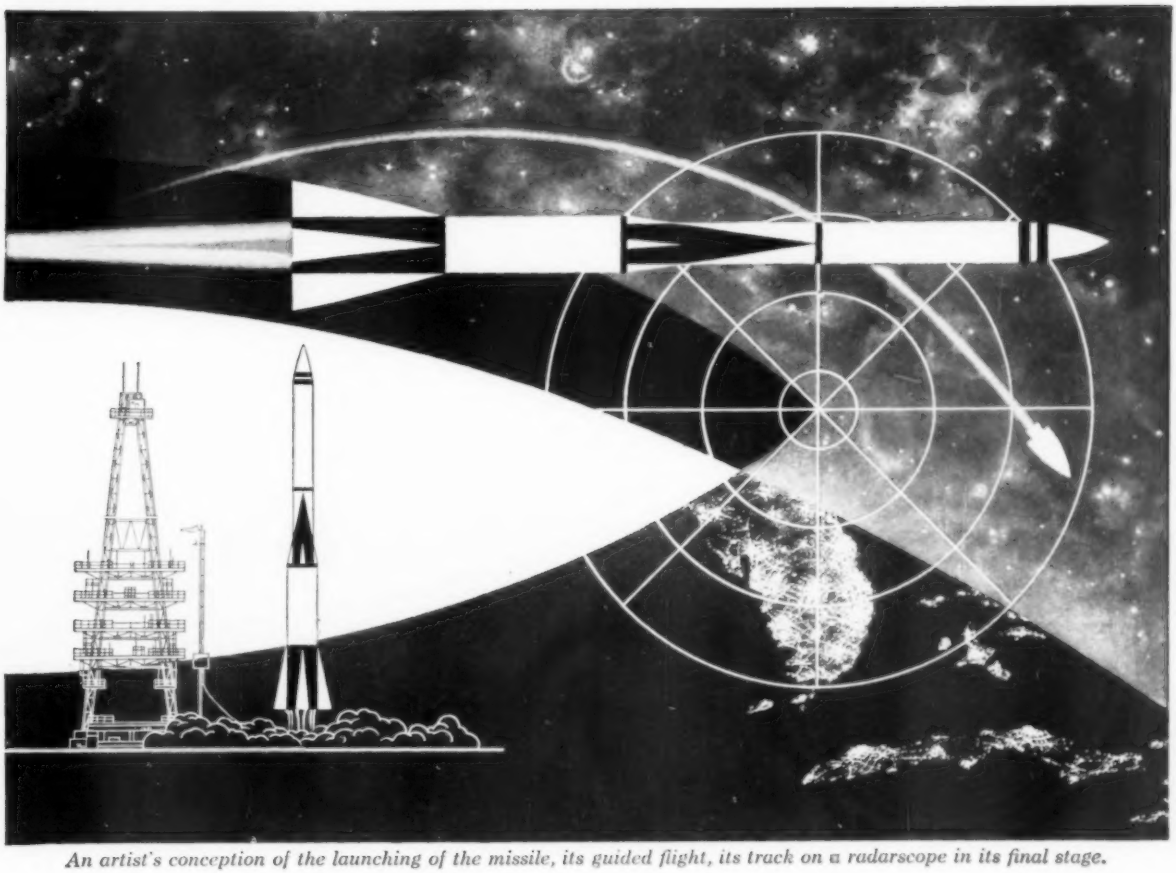
controlled against the cesium standard. Signals at 9180 mc. and 12.631830 mc. are derived from the 5-mc. oscillator. The 12.631830-mc. signal is frequency modulated at 100 cps. and added to the 9180-mc. signal. The sum signal at 9192.631830 mc., the cesium resonance frequency, is used to excite the r-f structure in the beam tube. Microwave power dissipation is less than 100 μw.

If the frequency-modulated r-f excitation is centered on the cesium resonance line, the rate at which transitions are induced will exhibit cyclic peaks at the modulating frequency. In effect, the beam tube recovers the frequency modulation in the form of amplitude variation in detector current. The a-c component in the detector output will be minimized when the r-f frequency deviation is symmetrical with respect to the cesium resonance line. Drift of the master oscillator will be reflected in an increased peak-to-peak variation in detector current. Phase of the a-c component relative to the output of the modulation generator indicates the sense of the error.

THE precision to which the master oscillator can be controlled depends fundamentally on the width of the cesium resonance line. Interaction between the beam and the microwave field is confined to the r-f cavity. Transit time through the field represents the effective duration of the r-f excitation. Accordingly, the resonance bandwidth can be taken as the reciprocal of transit time.

For a typical single cavity r-f structure the bandwidth for 3 db. response decrement is on the order of 200 cps. In principle, higher Q could be obtained by lengthening the r-f cavity or reducing the drift velocity in the beam. Phase shift and moding considerations rule out a simple extension of the cavity. At the expense of introducing a more complicated r-f structure, somewhat higher Q can be obtained by the use of two separately excited cavities. Reduction of atomic drift velocity without affecting other essential conditions also poses practical difficulties.

Use of a long vertical beam tube in which drift velocity would be reduced by gravitational deceleration has been proposed. In principle, at least, this scheme appears feasible. It has been estimated that control of a clock frequency to 1 part in 10^{13} might be attained with a retarded-beam atomic resonance standard. Although the term "atomic clock" is frequently applied to the cesium-controlled oscillator, this usage is somewhat misleading. The radiative transfer of energy which accompanies the resonance transition is not utilized directly for timing. Coherent integration, *i. e.*, cycle counting, is performed only on the output of the crystal-controlled master oscillator. The



An artist's conception of the launching of the missile, its guided flight, its track on a radarscope in its final stage.

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master oscillator rate is continuously sampled for comparison with the atomic reference.

A cesium-controlled frequency standard for laboratory service is commercially available. The equipment is accommodated in a 7-foot relay rack (18 by 22 inches). Weight is approximately 500 pounds. Service life of the beam tube is estimated at 1,000 hours. Frequency stability to 5 parts in 10^{10} is claimed subject to reasonable restrictions on operating conditions; *e. g.*, level within 10 degrees magnetic fields not to exceed 10 oersteds.

Smaller equipments for possible airborne applications are being developed. Significant reduction in size and weight probably will entail a roughly proportional reduction in performance. Length of the beam tube fixes the principal dimension of the apparatus. Shortening the tube could degrade collimation and adversely affect other characteristics, such as noise figure, which are influenced by geometrical parameters. However, the extremely high stability obtainable in the laboratory is not required for all uses to which a locally reproducible frequency standard might be put.

Remotely generated standards received by radio are subject to frequency perturbation because of propagation anomalies, particularly when sky wave transmission is involved. Variations in the received frequency of several parts in 10^8 are not unusual at long ranges.

It was noted in connection with the cesium-controlled oscillator that the radiation exchanged in the transitions between energy states was not utilized directly—*i. e.*, by r-f measurement.

However, operation of some types of resonance-controlled oscillators does require measurement of r-f power. The frequency-sensitive element of the ammonia clock, for example, is a length of waveguide filled with ammonia vapor. Microwave radiation at 23,870 mc. propagated through the waveguide is strongly absorbed by the ammonia. As the frequency of the controlled oscillator is varied through resonance, r-f power at the detector exhibits a sharp null.

By frequency modulating the microwave generator about the ammonia resonance frequency, a corresponding amplitude variation is produced in the detector output. The a-c component of detector current provides the necessary error signal for operation of an automatic frequency-control loop.

For several reasons, the ammonia absorption technique does not afford the degree of frequency stabilization which has been realized with the cesium apparatus. If the density of ammonia vapor in the absorption cell is low, microwave attenuation in the guide will also be small. Increasing the vapor density increases the attenuation coefficient but reduces the effective Q of the cavity because of molecular collision broadening.

Limitations due to Doppler shift and power saturation effects are largely avoided by the beam technique. The ammonia absorption controlled oscillator can be stabilized to about 1 part in 10^8.

Resonance transition of the ammonia molecule has also been utilized in a type of beam apparatus. A stream of ammonia molecules is passed through an electric field which effects resolution into components on the basis of energy state. Molecules in the ground state are deviated radially away from the beam axis and molecules in the excited state are converged by the field. The convergent beam is directed into a resonant cavity tuned to the relaxation emission frequency. Microwave radiation emitted as the molecules return to the ground state excites the resonant cavity. Short-term frequency stability to 1 part in 10^{12} has been demonstrated with this technique.

EDITOR'S NOTE.—With the advent of modern fire-control equipment and guidance devices for missiles the science of electronics is becoming more and more integrated with the science of ballistics, and a sound knowledge of electronics has become a necessary tool for the Ordnanceman.

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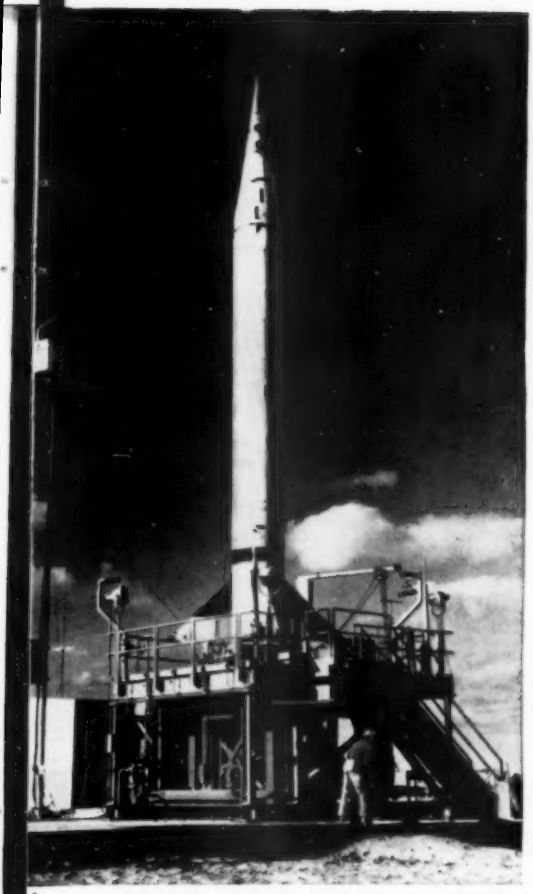
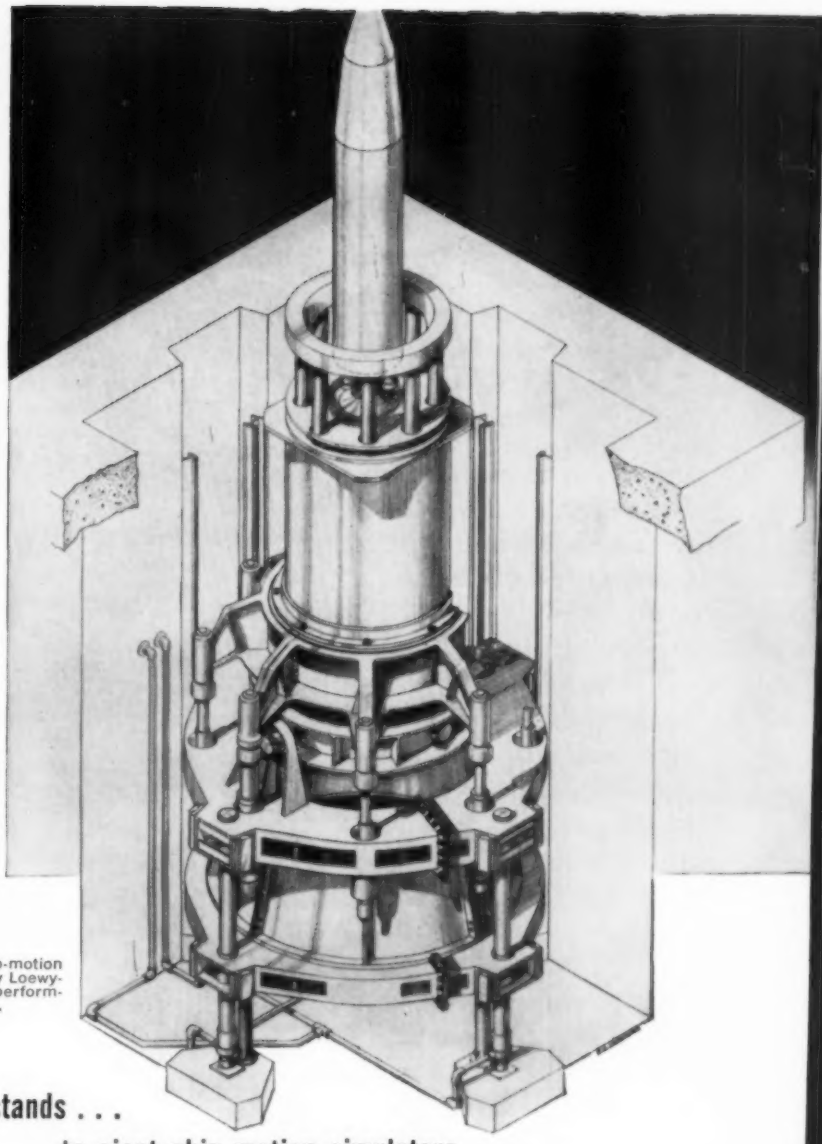


Static testing and launching stand for Vanguard Earth Satellite and Rocket designed and built by Loewy-Hydropress. Prime contractor—The Martin Company, Baltimore.



Engineer's isometric drawing of ship-motion simulator, designed and being built by Loewy-Hydropress, which will evaluate the performance of the Navy Fleet Ballistic Missile.

From static testing and launching stands . . .

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Loewy-Hydropress, which designed, built and installed the static testing and launching platform for the earth's first man-made satellite, has designed and is now building an enormous simulator to duplicate ship motions for the Navy Fleet Ballistic Missile Program. Involving several significant advances in the concept of automatic control of large forces, this simulator will be used for the purpose of checking guidance and fire-control systems, as well as handling, checkout, and actual firing procedures for ship-launched missiles.

The major function of the simulator will be to determine the limiting conditions under which a missile can be safely launched from a moving platform without interference from that platform. In so doing, this elaborate device will duplicate a periodic roll and pitch in any direction while simultaneously producing a heave motion. The simulator's supporting auxiliaries and environment—also by Loewy-Hydropress—will help create an integrated, functional and versatile research tool for the Navy.

The same talents responsible for the earth satellite launching platform and the ship motion simulator are available to help you solve your missile ground-support problems. Whether test facilities, or launching stands, or a combination of both, Loewy-Hydropress will supply a complete ground handling system.

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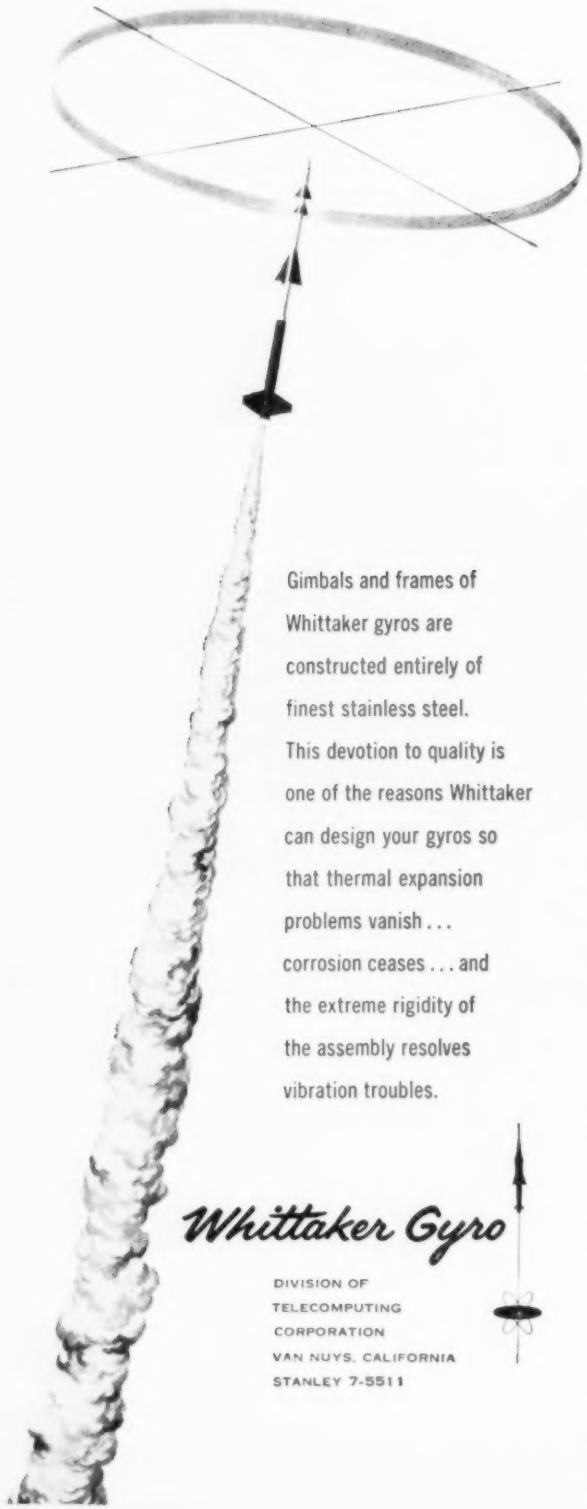

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MATERIALS PROGRESS

George S. Brady

Radiation Shielding.—Design analysis now calls for a new characteristic in construction materials—the ability of the material to shield against neutrons and to filter out gamma rays.

With a growth in the use of nuclear power plants, atomic batteries, and possibly yet undeveloped uses of atomic energy, this factor will become even more important, and the property must be incorporated either in the construction material itself, or shielding materials must be developed that will not take up too much weight and space. Much research is being applied to shielding materials, but the subject is still in its infancy.

The Boral produced commercially by the *Aluminum Company of America* was developed by the Atomic Energy Commission. It consists of aluminum or aluminum alloy plate containing 35 per cent of boron carbide, B_4C, uniformly dispersed in the metal, and the plates clad on both sides with pure aluminum. A ¼-inch Boral plate has a neutron-shielding power equal to 25 inches of concrete, but it does not stop gamma rays.

A new boron stainless steel of the *Superior Steel Company*, Carnegie, Pa., has a nominal content of 18 per cent chromium and 10 nickel, with an added content of 1 per cent boron. The boron occurs in the steel in a complex boride phase in an austenitic chromium-nickel-iron matrix, and it provides a neutron absorption 15 times greater than stainless steel.

While boron normally hardens steel and tends to make it brittle, the physical properties of this steel are comparable to ordinary stainless. It has a tensile strength of 90,000 pounds per square inch, with elongation of 10 to 25 per cent at Brinell hardnesses from 185 to 210, and its corrosion resistance is equal to 18-8 steel.

Information from the manufacturers indicates that ordinary boron is used in these alloys. But boron-10 is five times more effective in absorbing thermal neutrons than ordinary boron which is a mixture of boron-10 and boron-11. A given thickness of boron-10 is 10 times more effective than the same thickness of lead and 500 times more effective than concrete, and it is not radioactive. Boron-10 is offered for commercial use by the Niagara Falls plant of the Atomic Energy Commission. It is produced in the waste as a complex of 10 to 12 per cent B-10 with 88 to 90 per cent B-11. The B-11 is very transparent to neutrons, is useless as a neutron shield, and is separated out.

Where high structural strength is not a factor, it is possible to obtain neutron shielding with boron by using it in plastics or other materials as the carrier of the boron or boron compounds. But ordinary boron or boron-10 does not stop gamma rays as lead does. Several companies are offering lead-plastic compounds for the casting of shields and guard parts.

The Leadolene produced by the *Telectro Industries Corporation*, Long Island City, N. Y., consists of 5 per cent polyethylene resin with 95 per cent lead powder. The resin melts at a temperature of 220 degrees Fahrenheit for casting, and the material can be welded by heating the edges or by pouring the liquid material into joints.

But the proportion of lead metal used as a powder in plastics is so great that the lead-plastic compounds still retain the disadvantage of the heavy specific gravity of the original metal. Lead metal, at least in its normal form, is thus not the final answer for gamma-ray shielding. The great weight prohibits its extensive use on shipboard. There are indications that some complex organic molecular structures have good shielding powers. The answer to the problem may yet be found in the combination of some form of lead or other metal, or their iso-

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Materials Progress (Contd.)

topes, in alloys of the lighter metals as carriers, or with organo-metal compounds.

Atomic-Electrical Power.—Nuclear power at present is heat power requiring steam turbines. It will not be practical for aircraft until the nuclear energy can be turned directly into electrical energy. The Air Force believes that it can be done with semiconductor materials, and the Rome Air Development Center has been working on a transistorlike thermopile to produce the electrical energy directly.

The *Walter Kidde Nuclear Laboratory*, Garden City, N. Y., already has a tiny atomic-powered battery that has possibilities for missiles, rockets, transistorized radios, and hearing aids. The battery yields its electrical power direct from a silicon metal photocell with phosphors, and it derives its nuclear energy from promethium-147. This material has a half life of 2½ years, so that the battery should last for a period up to 5 years.

One of the small cells, not more than ⅜-inch in diameter and half as thick, has an output of 20 microwatts, and greater output can be had easily by building up a pile in series. A feature of the battery is that it will operate at very low subzero temperatures as well as at temperatures up to 200 degrees Fahrenheit.

Lightweight Radar Parts.—The entire platform, frame, and tripod of the new Paraballoon radar, built by the *Westinghouse Electric Corporation* for the Air Force, is of magnesium extruded channels and tubing and magnesium sheet. The Paraballoon is 20 feet in diameter and 30 feet high, but weighs only 1,730 pounds compared with 10,000 pounds for previous comparable sets. When disassembled, it can be packed in 200-pound airlift packages for quick movement to tactical centers.

Magnesium Missile Bodies.—Missile bodies of large diameter are being extruded of magnesium for the Air Force at the *Dow Chemical Company's* Madison, Ill., plant. The press, made in Germany, is capable of producing extruded sections up to 20 inches in width, large I beams, and tubing up to 24 inches in outside diameter.

Titanium Centrifuge.—The *DeLaval Steam Turbine Company*, Trenton, N. J., has developed a high-speed centrifuge of titanium alloy which is capable of a speed 28 per cent greater than for the same working stress with stainless steel. The alloy used contains 6 per cent aluminum and 4 vanadium, giving a yield strength of 120,000 pounds per square inch and weighing only 56 per cent as much as a stainless-steel unit.

Sulphur in Titanium.—Studies at the *Batelle Memorial Institute* indicate that small amounts of sulphur, as little as 0.004 per cent, refine the grain of titanium, and that an amount up to 0.025 per cent increases the strength with some drop in the ductility. It was found that an addition of sulphur to titanium alloys containing aluminum, molybdenum, or vanadium increases the yield strength. However, in titanium metal, when the sulphur is above 0.05 per cent, the sulphide appears in the microstructure and causes grain growth.

Zirconium Plates.—Zirconium is now available from the *U. S. Industrial Chemicals Company*, New York, N. Y., in the form of hafnium-free small plates up to about one-inch diameter at about half the price normally paid for hafnium-free sponge metal. The plates of solid metal are nonhygroscopic and nonpyrophoric and are much easier and safer to ship and store than sponge. The lowered price is the result of the new sodium-reduction process. The Bureau of Mines now has under way a project financed by the Atomic Energy Commission for electrorefining impure sponge zirconium, mill scrap, and scrap zirconium alloys to obtain pure reactor-grade hafnium-free zirconium.

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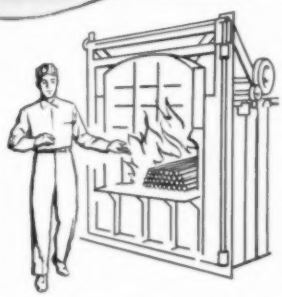

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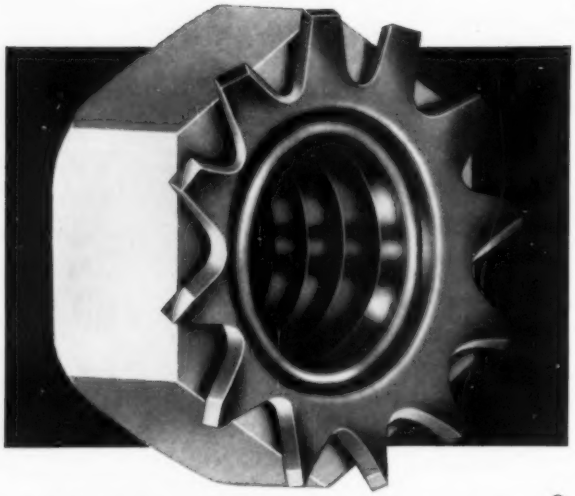

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Materials Progress (Contd.)

tories have shown that when iron is obtained in chemically pure crystal form it has a tensile strength of 500,000 pounds per square inch. The experiments were conducted on single crystal wires, or "whiskers," 0.000030-inch in diameter. In the pure crystal metal the interatomic forces bind the atoms tightly together, whereas in ordinary iron containing impurities there are structural imperfections which lower the strength to a tenth of the possible strength of the iron. The principle holds for other metals besides iron, and it is believed that pure crystal metals will meet new electronic applications.

New-type Plywood.—*General Plywood Corporation*, Louisville, Ky., is producing plywood with a new type of factory finish that eliminates the need of a sizing or primer coat for painting. The plywood is passed between high-pressure rolls which generate enough heat of friction to melt the lignin of the wood and fill the pores to a depth of 0.050-inch. The heat-pressure operation is so rapid that there is no danger of burning the wood. For woods low in lignin, or for special purposes, it is possible to apply a thermosetting resin before running through the rollers, whereby the heat and pressure diffuse the resin through the surface of the wood and cure it.

Manganese Ore.—The abundant rhodonite manganese ore of Colorado, hitherto considered unusuable, will now be employed for the production of metallurgical-grade manganese by a high-intensity arc process developed by the *Vitro Corporation of America*, West Orange, N. J. The ore contains 35 per cent or more of manganese, but the complex silicate nature of the mineral has made it difficult, if not impossible, to reduce by ordinary metallurgical processes.

The high-intensity arc, 7,000 to 10,000 degrees centigrade, vaporizes the ore into atoms of manganese, silicon, and oxygen, which then recombine into simple oxides of MnO and SiO_2 and condense into fine particles which can be separated easily and processed by chemical leaching.

Refractory Coatings.—Three types of refractory oxide coatings which have been applied successfully on jet-engine and reactor parts are now being offered by the *Norton Company*, Worcester, Mass., for heat, corrosion, and chemical resistance in industrial processing equipment. Rokide A is an aluminum oxide; Rokide Z is a stabilized zirconia; and Rokide Z5 is a zirconium silicate. Furnished in rod form, they are applied by a metallizing spray gun and produce an adherent, hard, crystalline, refractory coating that can be varied in thickness from 0.005- to 0.050-inch.

Bomber Construction.—The B-58 Hustler, an aircraft built by the *Convair Division, General Dynamics Corporation*, Fort Worth, Tex., for supersonic speeds and altitudes above 50,000 feet, has an airframe which consists of sandwich panels of two thin stainless-steel sheets separated by a honeycomb cellular core of thin stainless steel with edges bonded to the sheets. It gives a high strength-weight ratio in the structure, and a high resistance to the elevated temperatures of high speed.

The Nickel Supply.—In 1952 the President's Materials Policy Commission forecast that the supply of nickel needed annually by American industry would reach 200,000 tons by 1975. But now, with the fast-growing demand for the high-nickel types of stainless steel and high-nickel alloys for aircraft, rockets, missiles, nuclear power plants, and for heat and corrosion uses in the electrical, chemical, and other industries, it is estimated that not less than 150,000 tons of nickel annually will be required by the United States by 1960 unless manufacturers of less-essential civilian products voluntarily turn to alternate materials and cut back their use of the high-nickel alloys.

It is claimed that the governing factor in the use of high-nickel stainless steel by makers of dairy and restaurant equip-

ment, utensils, and table flatware, is the whiter color in comparison with plain chromium stainless. The working and welding characteristics of the less lustrous chromium steels have been considered inferior, but since the war these steels have been greatly improved.

Makers of railway cars and truck bodies have found the working ability and the mechanical properties of the newer 200 Series of stainless steels to be entirely satisfactory. They can be processed in the same tools as used for 18-8 stainless, and, because of the high content of manganese, the white color is even better than that of the 18-8 type.

These steels contain only about half the amount of nickel employed in the standard 18-8 steel. They cannot replace 18-8 steel for high-temperature use (1,500° Fahrenheit), but their use for the many other commercial applications would mean a substantial saving in nickel.

As an example of what can be done in saving nickel where appearance and corrosion resistance are important items, the *American Dispenser Company*, has replaced the stainless-steel parts of its Likwidurn soap dispenser with parts injection-molded from Du Pont's Zytel nylon resin.

Oil from Shale.—At a recent news conference in Washington on the Suez situation it was broadly hinted that the generally unsatisfactory terms of Egyptian operation would lead to definite plans for reducing Western-nation need of the Canal. One result appears to be a spurt in development of oil shales in Colorado and of the oil sands in Alberta.

Attracting attention to the Alberta area is a new centrifuge method, developed by the *Can-Amera Oil Sands Development Company*, for extracting an emulsion-free oil, leaving a valuable by-product in the clean mineralized sand. In Colorado, the *Denver Research Institute*, on a contract from the *Oil Shale Corporation*, Beverly Hills, Calif., has developed a modification of the Swedish process for producing oil and gases from plentiful local shale. In the process, porcelain balls preheated to about 1,200 degrees Fahrenheit are fed through the retort with the crushed shale.

Synthetic vs. Natural Rubber.—As mentioned in a previous issue, the Suez Canal is not essential to American import of natural rubber, but it is of economic importance to imports into Europe, and there is an increasing interest in extending the usage of synthetic rubber on the Continent. It is estimated that the United States consumption of synthetic in 1957 will be 950,000 long tons, an increase of 8 per cent over 1956.

Consumption of synthetic rubber is now 63 per cent of total rubber consumption, compared with 61 per cent in 1956. The Rubber Manufacturers' Association published figures to indicate that world consumption of natural rubber will continue to rise and level off to about two million tons, or about half of the expected total rubber consumption.

This estimate does not appear to take into consideration certain statistical and technical factors. There is as yet no great reduction of "natural synthetic," or isoprene rubber, and proponents of this rubber are enthusiastic regarding its ability to replace natural rubber. It is also a statistical fact that British companies have been reducing their capital in Malaya and selling out rubber estates.

From a British source comes an interesting comparison. It is stated that, while a synthetic rubber plant on 300 acres with 1,350 workers will go into profitable production in the second year and produce 90,000 tons of rubber annually, the same production of natural rubber requires 180,000 acres, 45,000 tappers, 10,000 other estate workers, and requires eight years to get into profitable production. There is also the factor that production from a synthetic plant can be gaged to balance demand and thus avoid deterioration losses in storage.

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ROCKETS AND GUIDED MISSILES

Alfred J. Zaehringer

Astronautics.—Latest word from our *Vanguard* satellite project indicates that the first launching may be in January 1958. There has been some trouble with the first-stage rocket engine but this is expected to be ironed out in time. Meanwhile, success has been reported for the third-stage rocket. The Grand Central Rocket Company solid-propellant engine has passed initial tests. The actual satellite sphere has taken a finished form.

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Under the name, *Project Snooper*, North American Aviation has advanced the idea of solar system reconnaissance by means of an unmanned rocket vehicle. The propulsion system uses ionized gases accelerated to very high velocities—over half a million feet a second. Because of the low thrust obtainable, the rocket is boosted from a satellite orbit by means of conventional chemical rockets. *Snooper* would then be placed in an orbit around one of the target planets.

Data about the planet would automatically be gathered and relayed electronically to the earth. Power for operating the instrumentation would come from the same nuclear-powered turbogenerator that supplies power for the ion rocket during the flight. Like our atomic submarine, *Snooper* will operate for over a year on its initial nuclear fuel supply.

Aërodynamics.—The Army has revealed its supersonic ballistic research track at Aberdeen Proving Ground. The 2,500-foot-long track is used to study rocket warheads and fuzes under captive conditions. The track was constructed at Gunpowder Neck in 1953, and the first firing took place in October of that year. Some 700 test rounds have now been fired. Propulsion comes from a Navy 5-inch HVAR. This aircraft rocket has been suitable for speeds above Mach 2. Shorter burning times, such as with the 3-inch rocket, have given speeds of near 4,000 feet a second.

Two new rocket sleds have been designed by Reaction Motors, Inc., for use at Edwards Air Force Base, Calif. Using 90 per cent hydrogen peroxide and JP-4 as fuel, the sleds develop 150,000 pounds of thrust for transsonic operation and 500,000 pounds for supersonic use.

At the *Snort* facility, China Lake, Calif., Aerojet-General has developed two liquid-propellant rockets for sled operation. Propellants are red fuming nitric acid with hypergolic fuel. Thrust is 35,000 pounds. The sleds were designed to reach speeds of up to 2,400 feet a second.

Preliminary design work of a circular sled track was shown for possible use at Eglin AFB, Fla. After whirling around a track of about 8,000-foot diameter, the sled is to enter a 500-foot-long straight section acting as a target. In 2,000 feet, a 2-stage rocket sled could reach a speed of over 3,500 feet a second.

Tests of rain erosion on missile radomes were made at the Edwards track by Convair. Ballistic tests made with 20-mm. and 57-mm. shells showed that erosion damage is a function of velocity, shape, material, water-drop size, and the distance the drop travels. For larger scale tests, a Mach 2 sled was designed using two 11,000-pound-thrust rockets with 2.2 seconds of burn-

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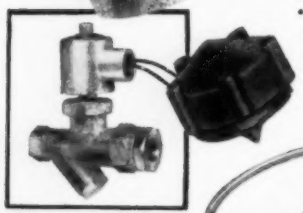

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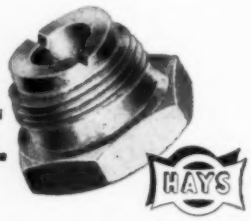

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Aim of the X-15 piloted research aircraft is an altitude of 200,000 feet and a speed of 4,000 miles an hour. The rocket plane is being designed by North American Aviation for the Air Force, Navy, and the National Advisory Committee for Aëronautics. This plane will fly twice as fast and high as the now-retired X-2 rocket plane.

Missiles.—Flight testing of two of our ballistic missiles—the *Thor* IRBM and *Atlas* ICBM will soon be under way according to latest Air Force reports. Work on the *Jupiter* IRBM and the *Titan* ICBM is also said to be in progress.

In addition to the intense emphasis being placed on ballistic missiles, our intercontinental cruise weapons are nearing operational status. The Northrop *Snark*, with a range of 5,000 miles, is reported to be ready for delivery to the Strategic Air Command. The North American *Navaho*, of similar range, is now being flight tested.

Tests on the new *Regulus II* are near completion and soon will operate from subs and ships. The new Navy missile is to get its power from a J-79 turbojet engine. Built by Chance Vought, speed will be in excess of Mach 1.5 at an altitude of over 50,000 feet. Range of the Regulus II is said to be 800 to 1,000 miles.

Another Navy missile, the ship-launched *Polaris*, is under development. *Polaris* is a rocket-powered ballistic missile with a range of 1,000 to 1,500 miles. Aerojet-General is working on the large solid-propellant power plant while Lockheed Aircraft Corporation is the main contractor.

Zuni is the Navy replacement for the World War II HVAR. The 5-inch rocket is used for air-to-air and air-to-ground use and is propelled by a solid propellant. Developed by the Naval Ordnance Test Station at China Lake, Calif., the rocket has folding fins and is said to cost $150 each.

In a recent test, the 3-stage *X-17* test missile reached an altitude of over 600 miles and a range of over 700 miles. Normally, the first stage is used for vertical take-off, then the missile tips over on its return to the earth and the other rockets are used to drive it down faster. The *X-17* is used to study the atmospheric reëntry of ballistic missiles.

Three sounding rockets have been shown by the Navy. The *Hasp* (high-altitude sounding projectile) is based on the Army *Loki* rocket and is to be fired from a 5-inch naval gun. *Hasp* will reach altitudes of over twenty miles to get upper-atmosphere data. Two other sounding rockets are also under development. These are the *Arcon* and the *Iris*. Both are being designed by Atlantic Research Corporation as solid-propellant rockets. *Arcon*, weighing 250 pounds, is 11 feet long, has a diameter of 6 inches, and will lift a 40-pound payload to an altitude of 70 miles. *Iris*, over 16 feet long, will reach 200 miles' altitude with a payload of 100 pounds.

Propulsion.—Two contracts for study of ion rocket motors have been announced. One group will be Rocketdyne, a division of North American Aviation, Inc. The other is Rias, Inc., a subsidiary of Martin Company. An ion system would obtain thrust by using high-velocity charged particles. Such a system would not produce anywhere near the amount of thrust developed by a chemical rocket. In space, however, an ion engine developing a few ounces or pounds of thrust might accelerate a vehicle weighing several tons to great speeds. Because of its low fuel consumption, an ion engine in theory would operate for several days or weeks. Conventional rockets consume all their fuel in a matter of minutes.

Another new system is being developed by Marquardt Aircraft Company. Called a turborocket, the rocket's exhaust drives a turbocompressor. The compressor rams air into the ducts around the rocket and out the nozzle to produce thrust.

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RECENT PATENTS

This department on recent military-industrial patents is being published in ORDNANCE *to keep our readers informed of the latest developments in these fields. The data are compiled by Melvin Nord, patent attorney, Detroit, Mich. Copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents each.*

Blast Suppressor.—*U. S. Patent No. 2,780,962. Issued February 12, 1957, to Murray Ressler and Howard S. Halpern. Assigned to the Secretary of the Navy:* This invention provides an improved blast suppressor for eliminating blast destruction, re-

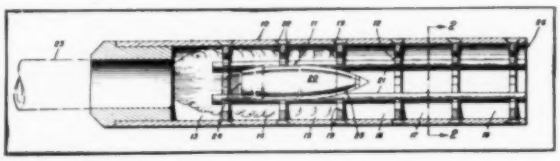


Fig. 1. Cross-sectional view of blast suppressor.

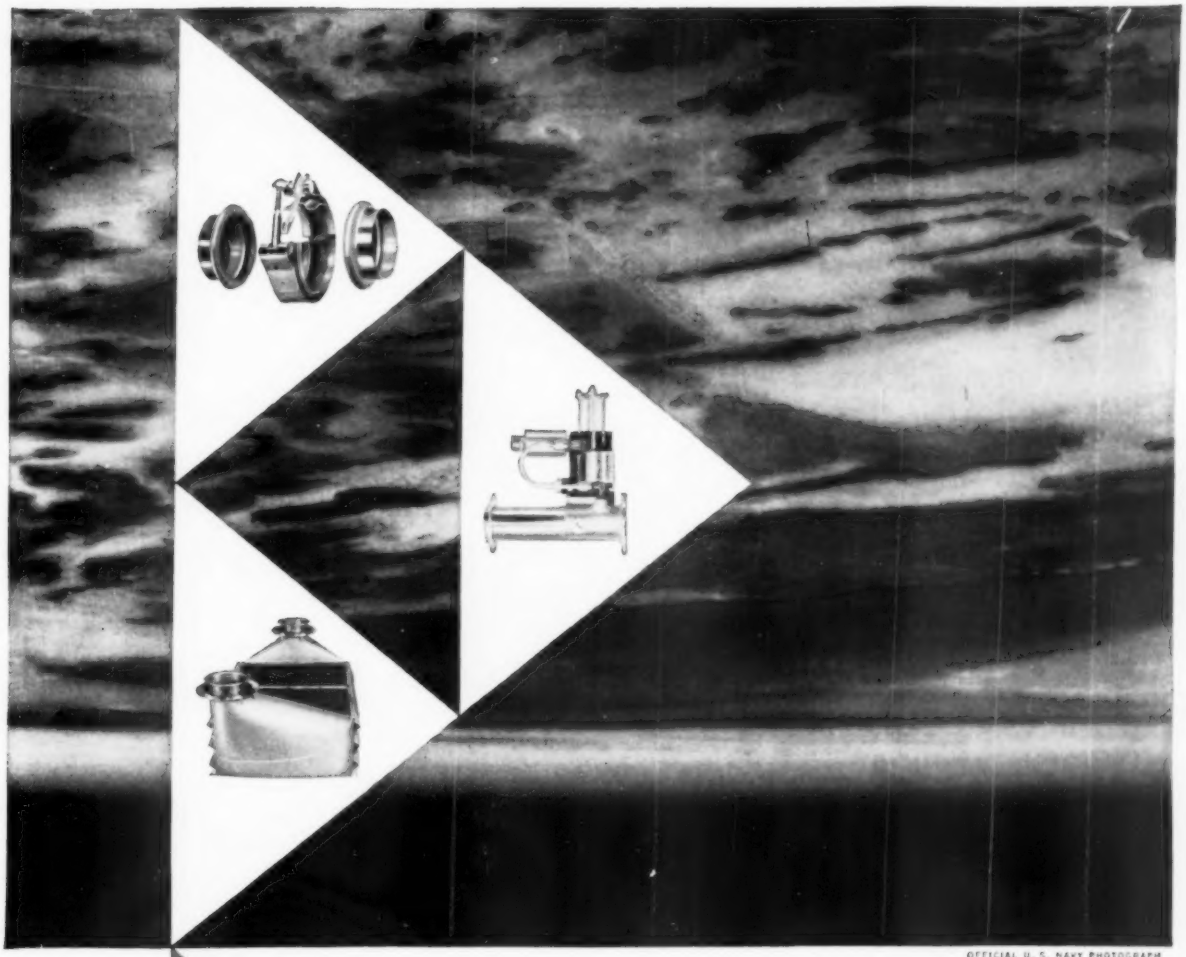
ducing flash and shock front pressure at the muzzle end of a gun.

As shown in Figure 1, the patent provides a blast suppressor with a tubular housing 10 which encloses a group of spaced baffle rings 12 forming gas compartments within which the hot gases surrounding the projectile 20 may expand rapidly to set up multiple wave reflections and turbulence, thereby dissipating the accompanying shock front pressure, the gas velocity, and the rapidly expanding gases surrounding the projectile.

Ignition of Rocket Fuels.—*U. S. Patent No. 2,775,863. Issued January 1, 1957, to Georges Traverse. Assigned to Société d'Étude de la Propulsion par Reaction:* The method of initiating ignition of rocket fuels provided here consists of bringing into contact with the propellant or propellants in the combustion chamber of the rocket a complex organometallic compound such as diethyl aluminum bromide or methyl zinc iodide. There is very little delay in the ignition—therefore the risk of explosion when ignition occurs is practically eliminated.

Missile Locator.—*U. S. Patent No. 2,775,951. Issued January 1, 1957, to Allen K. Billmeyer. Assigned to the Secretary of the Navy:* This invention provides a device for indicating the location of submerged articles such as test missiles. The apparatus effects the time-delayed release of compressed air. The bubbles which thus form indicate the location of the article.

Cannon Bore Scavenger.—*U. S. Patent No. 2,779,241. Issued January 29, 1957, to Wellington R. Howard and Waldo Margulis. Assigned to the Secretary of the Army:* This invention describes



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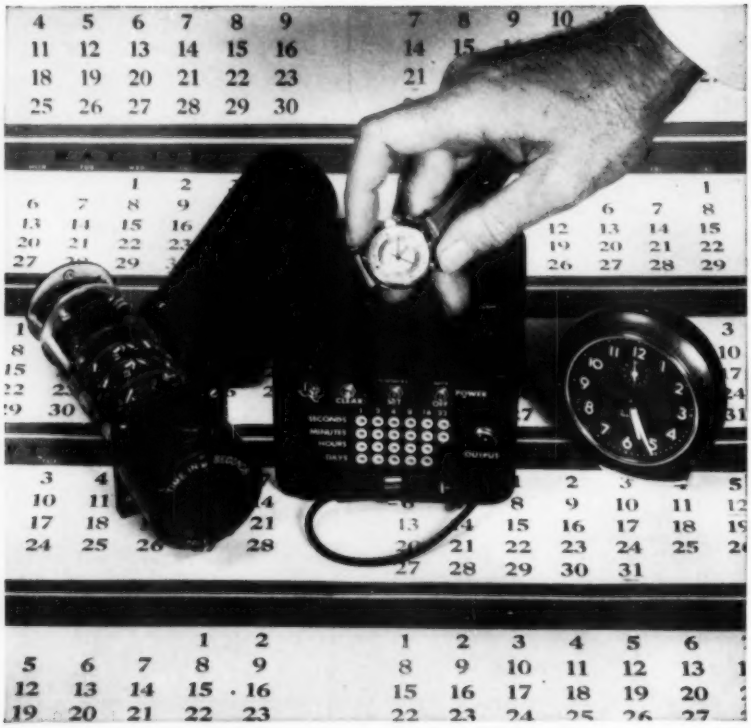

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Recent Patents (Contd.)

a device for evacuating the products of combustion of the propellent powder of a shell by way of the muzzle end of a cannon to prevent them from entering the firing compartment of the motor carriage upon which the cannon is mounted; *i.e.*, to prevent flashback or flareback.

The gaseous products of combustion are temporarily trapped under pressure in an expandable elastic "sleeve" which surrounds the gun barrel—the latter containing a number of perforations or gas ports leaking into the elastic sleeve. The trapped gases are then released at the moment the breech end is opened for evacuation into the barrel and out the muzzle end by an aspirating effect.

Underwater Firing Device.—*U. S. Patent No. 2,779,276. Issued January 29, 1957, to Frank A. Clary, Jr.:* This invention provides a pressure-actuated detonating device incorporating an electrolytic cell time delay device in which the anode plate of the cell is protected by a locking device from being broken by excessive shocks such as would occur during countermining.

Torpedo Exploder.—*U. S. Patent No. 2,779,277. Issued January 29, 1957, to Robert E. Smith:* This patent describes a torpedo exploder which avoids failure of the torpedo to explode as it strikes the target or premature firing of the torpedo due to pitch and roll or broaching during its travel. The firing of the torpedo is accomplished by a sudden movement of a movable coil from an initial position of rest within a strong magnetic field, thus generating an electrical signal of sufficient strength to fire a low-energy detonator as the torpedo strikes the target, regardless of the angle of impact of the torpedo with the target.

Jet Thrust Reversers.—Two recent patents describe methods of reversing the thrust of a jet engine stream in order to provide a braking effect for a jet airplane during landing. They are:

U. S. Patent No. 2,780,057. Issued February 5, 1957, to Harry Stavert. Assigned to Boeing Airplane Company.

U. S. Patent No. 2,780,058. Issued February 5, 1957, to Richard Derby Beale, Derek Howard Jubb, and Basil Charles James Stevenson. Assigned to Rolls-Royce, Ltd.

Free Floating Mine.—*U. S. Patent No. 2,780,994. Issued February 12, 1957, to Ralph D. Bennett:* This invention provides a free-floating mine including an inertia-responsive device having an element which is movable under the shock of a vessel striking the mine to cause the energization of an electrical circuit for firing the mine.

Practice bombs and Pylon tanks by PARISH that meet airpower's strict demands

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Van Trailer LM-105, front view, with jacks in position.

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Recent Patents (Contd.)

Protective Garment.—*U. S. Patent No. 2,779,331. Issued January 29, 1957, to Philip C. Trexler. Assigned to the Secretary of the Navy:* This invention provides a protective garment which shields the wearer from any liquid, gaseous, or solid agents, including particles of microscopic size (as in the case of germ warfare).

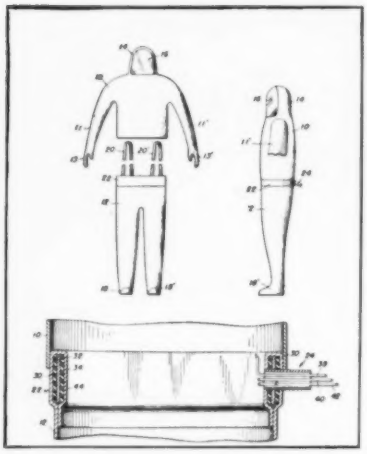

Fig. 2. Protective garment and waistband.

The garment and the seal between the two sections of the garment are shown in Figure 2. The suit is made of a thermoplastic such as vinyl film, except for the waistband 22, which consists of a metal band 30 covered on both sides with asbestos heat insulations 32 and 34. The rigid waistband acts as a support for the conduit 24, which contains an air inlet hose 40, an air outlet hose 42, and electrical wiring 30 to operate a microphone and head set. When the wearer has put the suit on, the upper section 10 and lower section 12 are fused together by means of a resistant band heater.

Bomb Tripper System.—*U. S. Patent No. 2,762,263. Issued September 11, 1956, to Otto H. Schmitt. Assigned to the Secretary of the Navy:* This patent describes an automatic system for releasing bombs from an airplane when it is directly above a submarine. The tripper system is activated in response to a magnetic anomaly caused by the presence of the submarine.

Liquid Level Indicator.—*U. S. Patent No. 2,764,890. Issued October 2, 1956, to Harry A. Toulmin, Jr. Assigned to the Commonwealth Engineering Company of Ohio:* This patent provides a liquid-level system in which photoelectric cells placed in an illuminated tank act to illuminate an area of an indicating gauge in proportion to the liquid remaining in the tank. The device is particularly suited for use in aircraft, since it also can be used for off-level flight indication.

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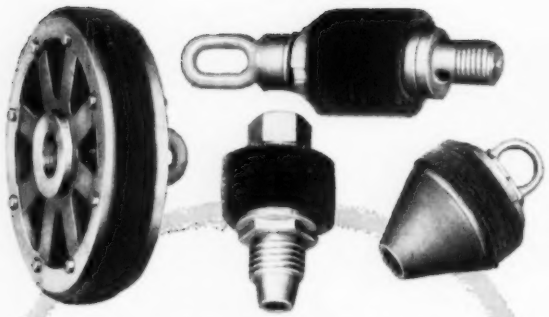

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Book REVIEWS

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COL. LEO A. CODD, *editor of* ORDNANCE, *Washington, D. C.*

COL. JOHN J. DRISCOLL, *author, air armament engineer, Weapons Systems Evaluation Group, Office, Secretary of Defense, Washington, D. C.*

DR. J. B. EDSON, *consultant on electronics, Research and Development Division, Office, Chief of Army Ordnance, Washington, D. C.*

E. B. ENGLISH, *manager, Governmental Division, Caterpillar Tractor Company, Peoria, Ill.*

F. W. FOSTER GLEASON, *military historian, ordnance analyst, editor, Washington, D. C.*

LIEUT. COL. S. M. SMOLENSKY, *engineer, Cambridge, Mass.*

Operation Deepfreeze. By Rear Adm. George J. Dufek. New York: Harcourt, Brace & Company. 243 pp. $5.

"OPERATION DEEPFREEZE" is Admiral Dufek's fine book about the Navy's Antarctic Task Force preparations for the International Geophysical Year, 1957-1958. It is a story, fundamentally, of two things: human ingenuity and courage—and modern equipment performing under the most unusual and exacting conditions.

The story is set against a backdrop of earlier polar expeditions and moves chronologically through the period of "making ready" into Deepfreeze I (winter of 1955-1956) and Deepfreeze II (one year later)—each operation having as its mission the establishment of such "beach heads" as air strips, semipermanent communities, outlying instrument stations, etc. There are moments of suspense and drama: lost airplanes, tractors falling through the ice and snow, the killing cold, the landing at the South Pole.

As for equipment, the wide-tracked, "low-ground-pressure" tractors—having as little pressure per square inch on the snow as a man on skis—are an example of what the military and industry, working closely together, can accomplish.

The book closes with what might be called the creed of all who explore the unknown: "Perhaps God has hidden so that men might discover."—E. B. ENGLISH.

Nuclear Reactors for Research. Edited by Clifford K. Beck. New York: D. Van Nostrand Company. 267 pp. $8.50.

THE Geneva Conference in 1955 was a showcase for the accomplishments of men and nations. There the masters of research reactor technology presented papers which are here edited and compiled into a single volume by C. K. Beck, who created the world's first non-Government-owned and -operated research reactor at North Carolina State College.

Part I, "Research Reactors and Their Uses," is especially arranged to aid the staff of a research institution in deciding whether the institution should acquire a reactor and, if so, what broad design choices are involved. Part II describes the design features of all reported research reactors throughout the world, outlines the programs accomplished with them, and in many

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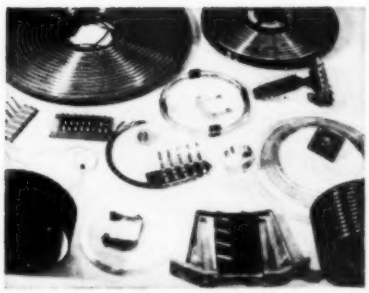

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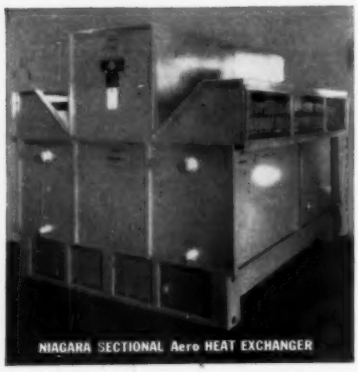

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INDEX TO ORDNANCE

VOLUME XLI

● The Index to Volume XLI of ORDNANCE, with title page for binding, is now available. It will be sent free of charge upon request to the Editorial Offices at the address below.

● It covers subjects in the following 1956 and 1957 issues: July-August (No. 217); September-October (No. 218); November-December (No. 219); January-February (No. 220); March-April (No. 221); and May-June (No. 222). It is arranged alphabetically by subject and author.

AMERICAN ORDNANCE ASSOCIATION
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cases presents operating experience or incidents of interest to designers and operators.

It appears likely that this volume, with the rest of the "Geneva Series on the Peaceful Uses of Atomic Energy," will become a standard reference work in the field.—J. B. EDSON.

The Life of Hilaire Belloc. By Robert Speaight. New York: Farrar, Straus & Cudahy. 552 pp. $6.50.

HILAIRE BELLOC, whose amazing pen over more than half a century produced some of the best military historical analyses, was a genius of the first rank. As a military historian his talents reflected a breadth of viewpoint and accuracy of detail which have not been surpassed by many others in the long record of military historical writings.

The pages of this journal were fortunate enough to publish some of his essays over the years. Indeed, the Ordnance Association was privileged to have him as a speaker at one of its annual meetings shortly before the beginning of the Second World War.

This biography for more than 500 pages is the definitive record of a great man, his background, his philosophy, his politics, and his religion. And it is much more, for it is a composite portrait of a soldier, poet, and uncompromising fighter. The record of his life and work will stand for many a day to guide students of military as well as political progress.

This biography by Mr. Speaight takes its place at the head of the list—and so it should for it is the authorized record by Mr. Belloc's literary executors. All students of military history would do well to have it on their library shelves for inspiration as well as for accuracy.—LEO A. CODD.

History of Germany—From the Reformation to the Present Day. By Minna R. Falk. New York: Philosophical Library, Inc. 438 pp. $6.

PROFESSOR Falk is well equipped for her formidable task. Several years' service in military government in Germany and Austria, twenty-five years of teaching German history, and an understanding of space limitations prevent any approach to inefficacy, yet the volume necessarily has shortcomings. Four centuries of history of a land as important yet as divided and fought-over as this is impossible to compress into less than 500 pages.

Yet a very great deal has been done. As a refresher of the boiled-down facts, or the imparter of an adequate outline, this is a surprising success.

A short condensation of pre-Reformation history is followed by longer accounts of the Thirty Years' War, of the emergence of Prussia under Frederick, the Napoleonic struggles, and the unification of less than a century ago. Both World Wars and the period between are accorded some detail.

But it is in the study of the postwar years that the author concentrates her thought (though it appears without allotting enough space). Still, the book has great interest to all and will be a real value to any one who deals with the problems of modern Germany.—F. W. FOSTER GLEASON.

American Natural Resources. Edited by Charles H. Callison. New York: The Ronald Press Company. 211 pp. $3.75.

THIS book is not a study of resources from any industrial angle. It is an elementary general review, made for the Natural Resources Council of America, of our land, water, forestry, and wildlife, with discussion of the conservation measures being taken to preserve these basic resources in perpetuity.

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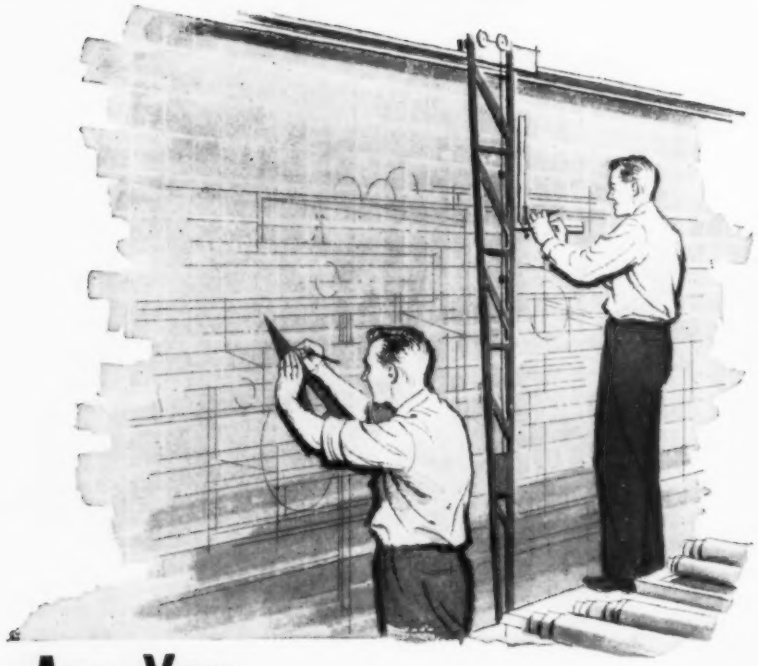

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ground for an informed approach to the problems of basic resource conservation, the author has assembled chapters written by authorities on soils, water, grasslands, forests, wildlife, fish, parks, and wilderness. The book does not aim to be technical and is written in easily understood form.

It is too sketchy for the technical student, but its information is basic, and it could serve as an introductory to a broader viewpoint on natural resources than is ordinarily attained by those dealing separately with industrial materials.—GEORGE S. BRADY.

Soldiers and Scholars—Military Education and National Policy. By John W. Masland and Laurence I. Radway. Princeton: Princeton University Press. 530 pp. $7.50.

SINCE World War II, particularly with the advent of the thermonuclear age, the traditional distinction between military and political affairs in American life has become less significant. Military officers find themselves increasingly participating with civilian officials in formulating national policies.

"Soldiers and Scholars" deals with the impact of this situation upon our current professional military education and its future. This survey is based on a first-hand investigation of the programs at our military academies, R.O.T.C., command and staff schools, Armed Forces Staff College, National War College, Industrial College, and other institutions.

Objective and interesting conclusions are presented on how well our system of military education does prepare officers for policy rôles and foster creative military service under civilian leadership in a democratic society. Constructive criticisms and recommendations are also presented for improving our system of advanced military education.—STANLEY M. SMOLENSKY.

As France Goes. By David Schoenbrun. New York: Harper & Brothers. 341 pp. $5.

AFTER five years' service in France it became clear to this reviewer that a close continuous acquaintanceship with numerous French people in all walks of life is vital if one wishes to acquire a sound understanding of the inner workings of the average Frenchman—and, consequently, to understand France.

How, then, is the average American to be expected to get a true appreciation of France, especially when he is not really acquainted with a single French citizen and has an inadequate knowledge of French history?

Is France a reliable ally? Why can't the French keep a government in office? Why don't they pay taxes? The answer

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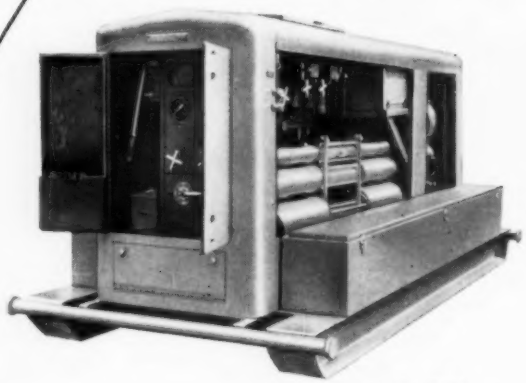

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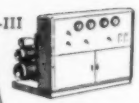

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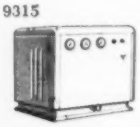

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to these and many other questions lies deep in French history, and we are fortunate in having available in "As France Goes" a most brilliant appraisal of these and many other problems. David Schoenbrun, as CBS correspondent for more than ten years, has been an on-the-spot observer of many important recent facets of French history in the making. He also has a masterful knowledge of earlier French history and its impact upon current events.

The author gives a "case history" of France beginning with Julius Caesar's arrival over two thousand years ago, right up to the birth of the Fourth Republic. This is followed by a "clinical examination" of the political party framework; a "functional examination" of the parliamentary history and the "manners, morals, and mores" of the French; winding up with an "external examination" of the history of the colonial problems.

Schoenbrun's analysis may soon be recognized as the best contemporary diagnosis of France—"the sick man of Europe." His evidence reveals that France may not really be dying, but that she may be rising "clearer, more bright than ever." —JOHN J. DRISCOLL.

High Speed Flight. By E. Ower and J. L. Naylor. New York: Philosophical Library, Inc. 227 pp. $10.

IN every art there is a set of simple ideas by which the professionals guide their thinking. Many of these insights and guidelines for high-speed aëronautics are in this volume.

So, if the Mach-talk and Prandtl-prattle of your supersonic friends flutters your nerves and ups your circulatory Reynolds number, this well-printed, well-illustrated book can help. For any one with a basic knowledge of engineering, the reading will be smooth and easy, but not rapid.

Nearly all aspects of fast flight are covered from their earliest beginnings to May 1956. Topics include flight fundamentals, engines, structures, materials, human factors, the rôle of sonic velocity, and aërodynamics research.

The authors are well-known experts in aëronautical research. E. Ower is a former secretary of the Scientific Advisory Council of the British Ministry of Supply, and J. L. Naylor is Secretary of the Aëronautical Research Council of Great Britain.— J. B. ENSON.

Graf Spee—The Life and Death of a Raider. By Dudley Pope. Philadelphia: J. B. Lippincott Company. 256 pp. $3.95.

THIS is a seaman's detailed, minute-by-minute account of the operations and destruction of the ship that was the pride of

THE CURTAIN OF FIRE Air protection for whole cities and strategic areas is no longer in the "talking" stage. It is now being installed—a combination of the deadly fire of NIKE anti-aircraft weapon batteries and the U.S. Army Signal Corps' new Martin MISSILE MASTER. As the country's first electronic system designed to provide an integrated screen of radar surveillance, target detection and fire coordination, MISSILE MASTER makes possible peak effectiveness of anti-aircraft missile battery operation. A measure of the critical importance of MISSILE MASTER is the fact that the system already has been designated for a number of our most vital civilian and military areas. It is one of the most significant defense developments of our time.

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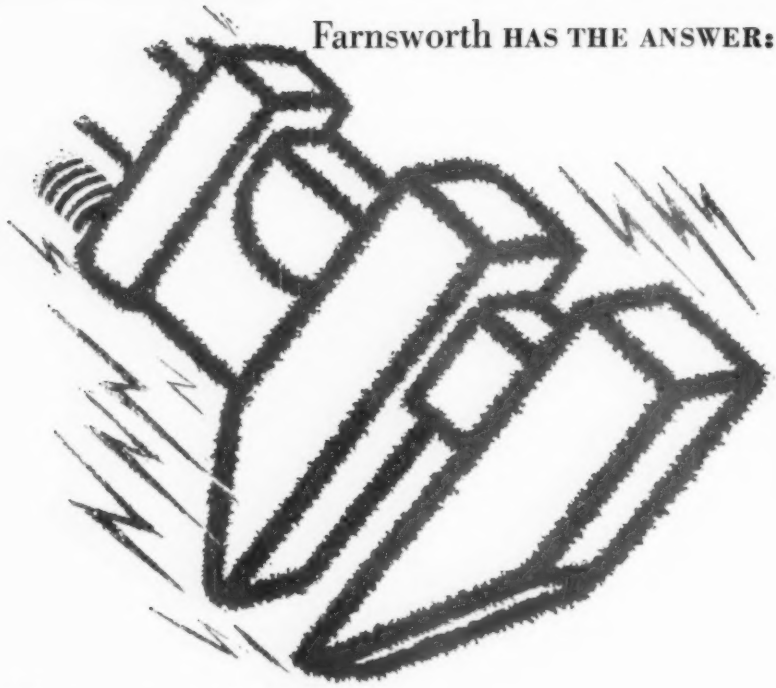

How to throw an *Electronic* Monkey Wrench

Attack . . . counterattack . . . offense . . . defense— for every tactical movement there must be an effective answer. That is why we must be able to employ a defense that literally "throws a monkey wrench" into the enemy's operations.

Our very survival may depend upon what is known to the military as—countermeasures. These embrace most of the sciences; they call for vast knowledge, many skills and unlimited imagination . . . in the use of radar, infrared, microwave, and other techniques.

Farnsworth scientists and engineers have these abilities and facilities . . . that is why they have been selected to devise, test, and produce various electronic countermeasure systems and equipment that will confuse, stall, and stop the enemy.

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the German Navy. This is the first account that traces the activities of the GRAF SPEE from the moment she slipped from her moorings in Wilhelmshaven in the evening of August 21, 1939, to the terse cable sent to Berlin on December 17, 1939, announcing that she had been blown up by her crew.

This is the story of one of the most dramatic incidents in the annals of sea warfare. "The last of the great naval actions before aircraft and radar changed sea warfare and put an end to tactics that Nelson might have used."

How a superb ship, possessing the utmost of German technology, is tracked down by three hopelessly outgunned British light cruisers is told in a very stirring fashion and reaffirms the importance of *esprit* and tenacity of purpose in warfare. —STANLEY M. SMOLENSKY.

The Art of Spying. By Ronald Seth. New York: Philosophical Library, Inc. 183 pp. $6.

THIS is an interesting and easy-reading adventure tale, but it hardly lives up to its title as descriptive of an art. The author is an experienced writer and something of a specialist on spying, but in this book there is no show of analytical discussion. He has produced a volume consisting of five separate stories of spies, more like the conventional tales of the buccaneers than any analysis of the art which they practiced in their adventures.

It would appear that the five cases presented were selected for their madcap adventure aspects, whereas a study of the art of spying might better have been taken from case histories of trained spies operating from accredited bureaus of the various governments.—GEORGE S. BRADY.

BOOKS RECEIVED

Conquest of the Antarctic, The. By Norman Kemp. New York: Philosophical Library, Inc. 152 pp. $4.75.

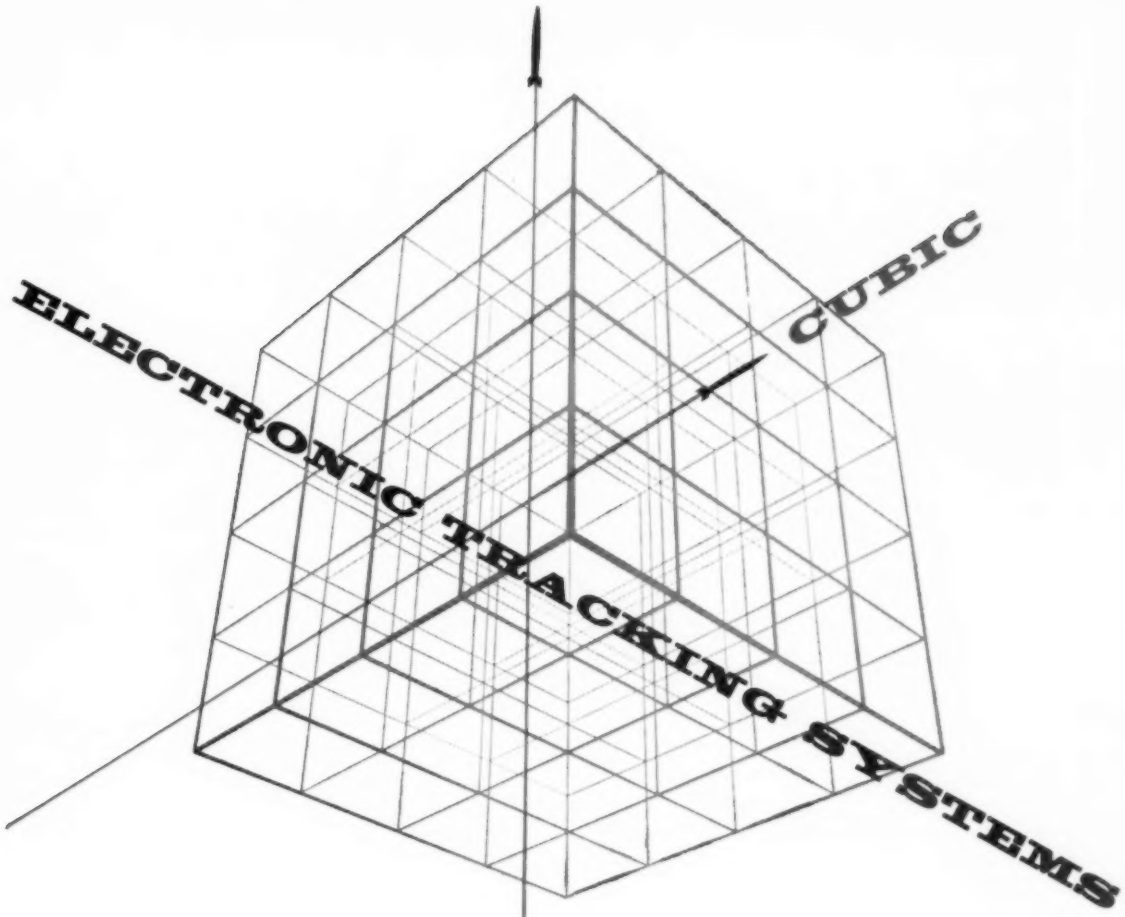
Here Is Haiti. By Ruth Danenhower Wilson. New York: Philosophical Library, Inc. 204 pp. $3.50.

National Communism and Soviet Strategy. By D. A. Tomasic. Washington: Public Affairs Press. 222 pp. $4.50.

Proceedings of the RETMA Symposium on Applied Reliability. Sponsored by the Engineering Department of the Radio-Electronics-Television Manufacturers Association. New York: Engineering Publishers. 105 pp. $5.

Radio Aids to Air Navigation. By J. H. H. Grover. New York: Philosophical Library, Inc. 138 pp. $6.

United States Army in World War II—The Transportation Corps: Operations Overseas. By Joseph Bykofsky and Harold Larson. Washington: U. S. Government Printing Office. 671 pp. $6.50.



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airborne package: less than 0.01 cu ft

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AIDED TRACKING
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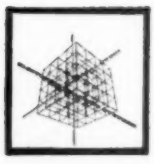

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1

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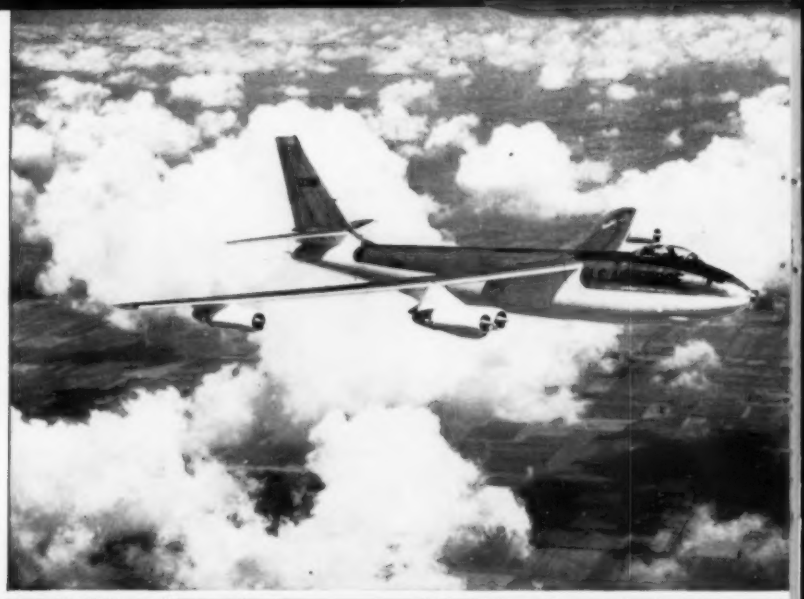
While building more than 1,500 Y-4 bombsights for B-47 Stratojets, we improved original design, exceeded USAF specifications. Thorough testing at all stages of production assured perfect assemblies. *We delivered on schedule!*



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B-52

We make Hemisphere Sights for the MD-9 tail defense system in the B-52 Intercontinental bomber. This optical gunsight has a high degree of electronic automation. It calls for exacting manufacturing and environmental testing.

3

B-58 HUSTLER

The B-58 Hustler, the world's first supersonic bomber, carries a series of key assemblies engineered and produced by the Mechanical Division under sub-contract for Emerson Electric Corporation. Military security prevents detailed description of these ultra-precise electro-mechanical units.

CLASSIFIED

These are some of the men, recognized leaders in their fields, who head the integrated departments that team to provide complete systems service.

From the left: Dr. Howard H. Baller (radar and countermeasures, computers); Dr. Cledo Brunetti, Managing Director of Engineering, Research and Development (electronic design, automation); Donald F. Melton (nuclear handling, automation equipment); Dr. John E. Barkley, Director of Research (solid state, infrared); Zeke Soucek (seated), General Manager; Dr. Carl L. Kober, Director of Development (radar, infrared and inertial systems); Harold E. Froehlich (balloons and meteorological systems); Dr. Otmar M. Stuetzer (microwave optics, semi-conductor physics); Dr. Gottfried K. Wehner (behavior of metals in space flight).

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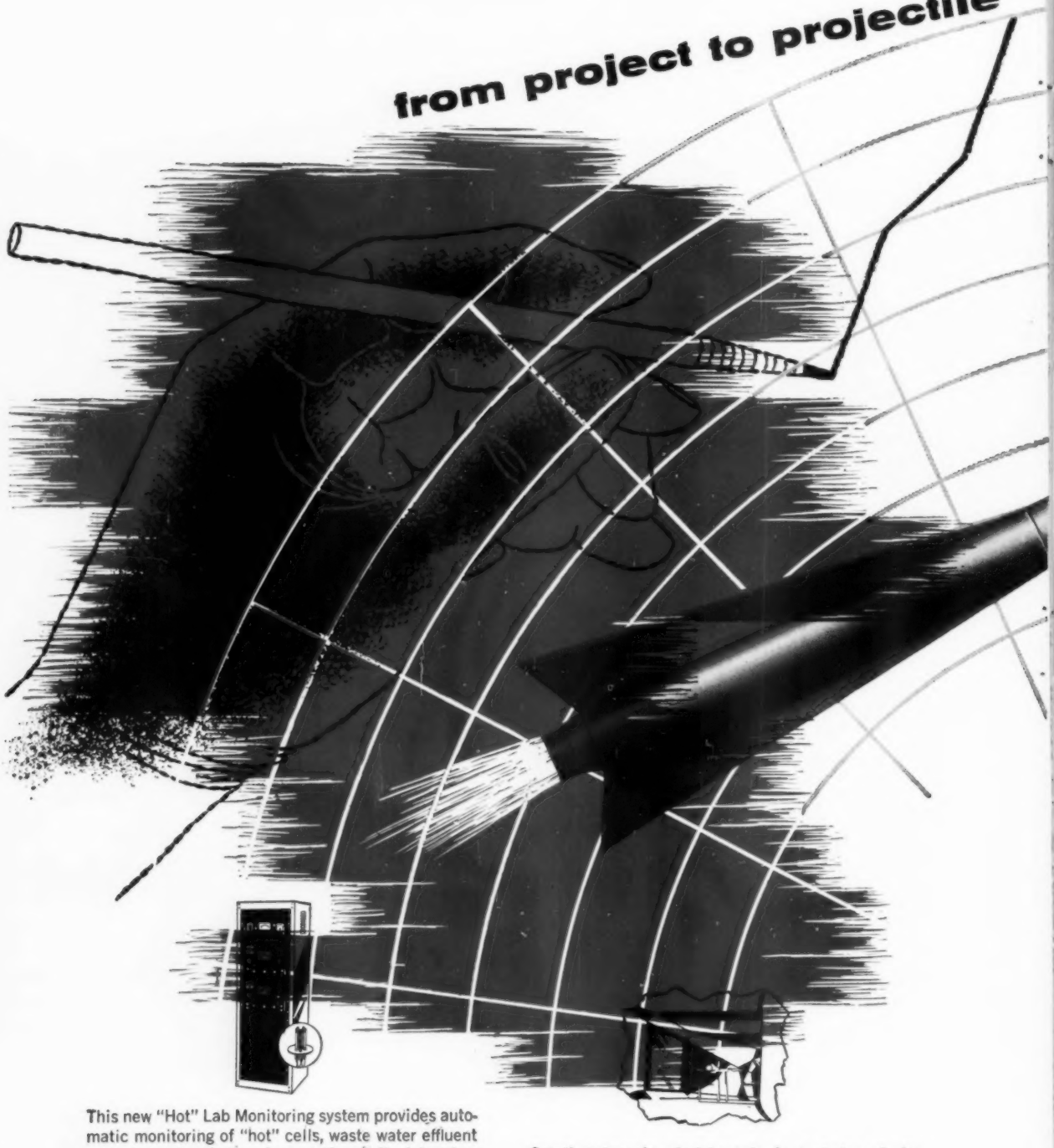
from project to projectile



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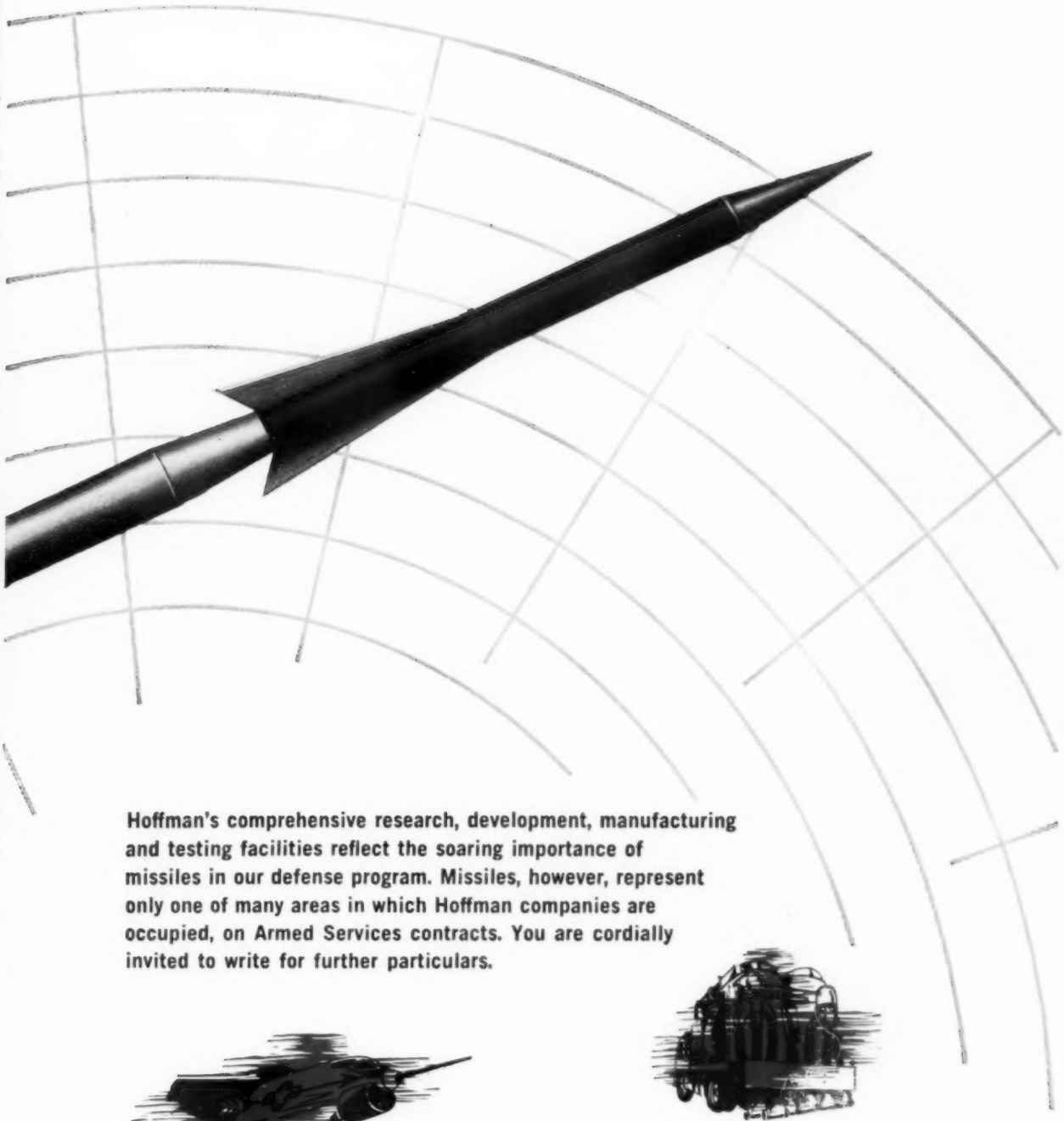

Hoffman's comprehensive research, development, manufacturing and testing facilities reflect the soaring importance of missiles in our defense program. Missiles, however, represent only one of many areas in which Hoffman companies are occupied, on Armed Services contracts. You are cordially invited to write for further particulars.

Nose and front fuselage sub-assemblies for Navy "Crusader" supersonic fighter planes are a portion of the production by a versatile organization.

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The Hoffman JARC* creates a 350 mph scrubbing velocity which thoroughly cleans jet aircraft runways of surface material that would otherwise endanger jet turbine blades and engines. Other air appliance and filtration engineering by the

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The above familiar phrase is usually given as a definition of genius. We borrow it as a job description.

The lengths to which our Quality Control people go, to insure the reliability of our complex products, are truly painstaking, and are applied equally to components we make ourselves and those we purchase from outside suppliers.

For example, consider vacuum tubes, the heart of hundreds of projects in our Electronics Division. No spot check satisfies here (even if that's all our customer specifies)—but a whole series of critical tests, including such precise evaluations as these:

Inspection of tube characteristics to rigid Stromberg-Carlson specifications—performed on special equipment which can do in a half-hour what would take days on conventional testing devices.

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Inspection by microscope, seeking welding faults, minute cracks in glass, and even infinitesimal loose particles inside the tube.

And tubes are only one concern. *All* components must pass similarly rigid tests, to assure operating performance, ruggedness and reliability in the completed equipment.

You can't put a price on "taking infinite pains." You *can* place your confidence in a company where this is everyday procedure.

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to reach the stars
start at the bottom!

How will men react to group-solitude for months (and years) on end? What happens in a weightless void? Disorientation, boredom, pain? What of the isolated space vessel itself? What happens to men and machine at photonic speeds?

Similar problems—in their particular contexts—have been solved by Electric Boat brains for over 50 years.

Years before men could survive in their new nuclear submarine world, the feasibilities of such existence were explored and solved by the "Integrated Concept Technique" of Electric Boat Division of General Dynamics Corporation.

No feasibility problem can be solved piece by piece. The Electric Boat's "Integrated Concept Technique" analyzes and interprets the problem as a whole.

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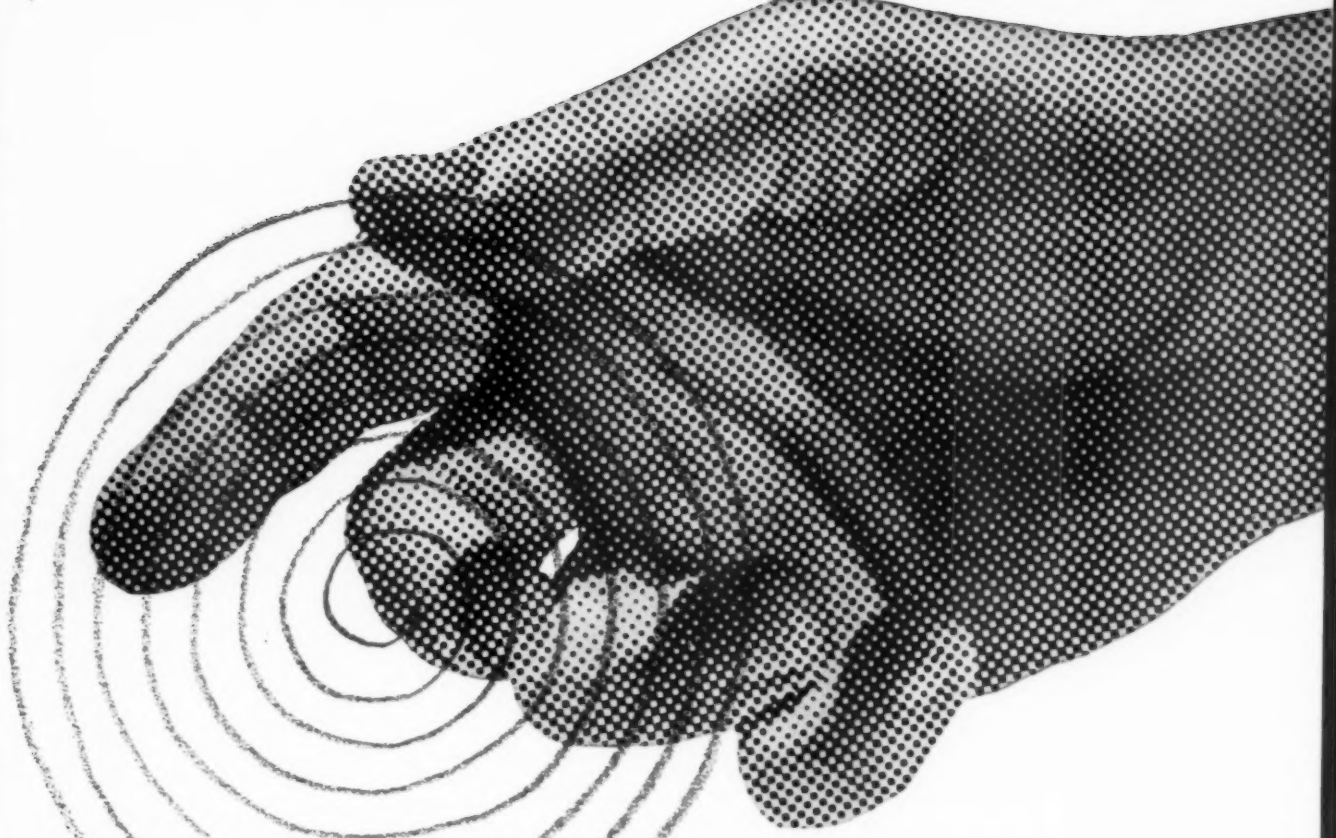

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Skilled hands coupled with keen minds made today's rocket powerplants a reality. Minds that formulate new theories in powerplant design . . . and hands that prove these theories by careful experiment, test and application.

Guided by such hands and minds, RMI has led the way for over fifteen years—designing and producing record-breaking powerplants for such supersonic vehicles as the X-1A, Skyrocket and the Viking missile. Today and in the future, RMI engineers and scientists will continue to blaze the trail toward advanced propulsion systems for manned and guided flight.

Engineers, Scientists—Perhaps you, too, can work with America's *first* rocket family. You'll find the problems challenging, the rewards great.

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First, Earth was all,
then the Sun, and then our Galaxy
of 100,000 million suns,
"like sand . . . flung down by handfuls
and both hands at once".
Now, we know our galaxy
is but one among a billion galaxies
where suns and earths
and atoms are ceaselessly created
by a Universe without
beginning and without end.

worlds without end

Political corollary: If nations may
forsake wars of aggression and deterrence
for a cooperative deployment
of earth's resources to explorations
in space and time, the new science of
astronautics may lead us soon
to the infinite plenty of the planets
and the stars.

STRATOPOWER Aircraft Hydraulic Pump

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Railroad Air Brake equipment of all types; STRATOPOWER Hydraulic Pumps and Motors for Aircraft, to 5000 psi for operation to 400° F.

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HYDRECO Hydraulic equipment for industrial and mobile applications. Gear and Dual-Vane Pumps and Motors to 2000 psi, to 120 gpm, to 120 hp. Control Valves to 2000 psi and 150 gpm. Cylinders: Telescopic, Single and Double-acting to 10" diameter, strokes to over 20 ft.

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AURORA Centrifugal Pumps to 8500 gpm and 600 ft. heads. APCO Turbine type Pumps, 5 to 150 gpm, heads to 700 ft. Condensate Return Units 800 to 100,000 sq. ft. radiation.

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High Vacuum Mechanical Pumps, single stage, 13 to 780 cfm, pressures to .01 mm Hg; two stage, 2 to 46 cfm, pressures to .0002 mm Hg; Mechanical Booster Pumps, 30 to 5000 cfm, pressures to .0001 mm Hg. Rotary Liquid Handling Pumps to 3000 gpm.

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Complete KINNEY Vacuum Systems—Vacuum Furnaces (Arc, Induction or Resistance), Evaporators, Optical Coaters and Metallizers, TV Tube Aluminizers; Oil Diffusion Pumps, Gages, Valves and Oils.

Forces are so great and response requirements so exacting at today's air speeds that no man is strong enough or quick enough to adjust controls for even the simplest maneuver. Yet, a STRATOPOWER Hydraulic Pump, smaller than a football, provides Fluid Power that enables a pilot, with no more than a "fingertip flip," to perform, precisely and instantly, a dozen jobs. Among these are: raising and lowering landing gear, operating control surfaces or wing flaps. And, STRATOPOWER Pumps with their amazing weight/horsepower ratio perform many other supplementary chores in the air such as: powering air conditioning and pressurizing equipment, radar scanners and other jobs that Fluid Power does better.

More and more, industry looks to Fluid Power to perform functions more rapidly, more perfectly, more economically. Today's Materials Handling equipment is one example wherein HYDRECO Hydraulic Gear Pumps and Motors, Valves and Cylinders have saved untold millions of man hours. Dual-Vane Hydraulic Pumps and Motors bring to Machine Tools and Mobile Equipment the advantages of 2000 psi operation. Engineers of The New York Air Brake Company are ready to render assistance wherever a Fluid Power problem exists or may be under consideration.

In addition to two Divisions specializing in Power Hydraulics, there is valuable "know-how" in Liquid Handling at Aurora Pump and Kinney Mfg. Divisions plus intimate knowledge of Vacuum Processing in the Kinney Mfg. and Vacuum Equipment Divisions.

As Fluid Power plays an increasingly important role on land, sea and in the air, it becomes more important to you to become better acquainted with the *Imaginative Engineering* of The New York Air Brake Company.

Write today for FREE literature from the N. Y. A. B. Division whose products are of interest to you.

THE NEW YORK AIR BRAKE COMPANY

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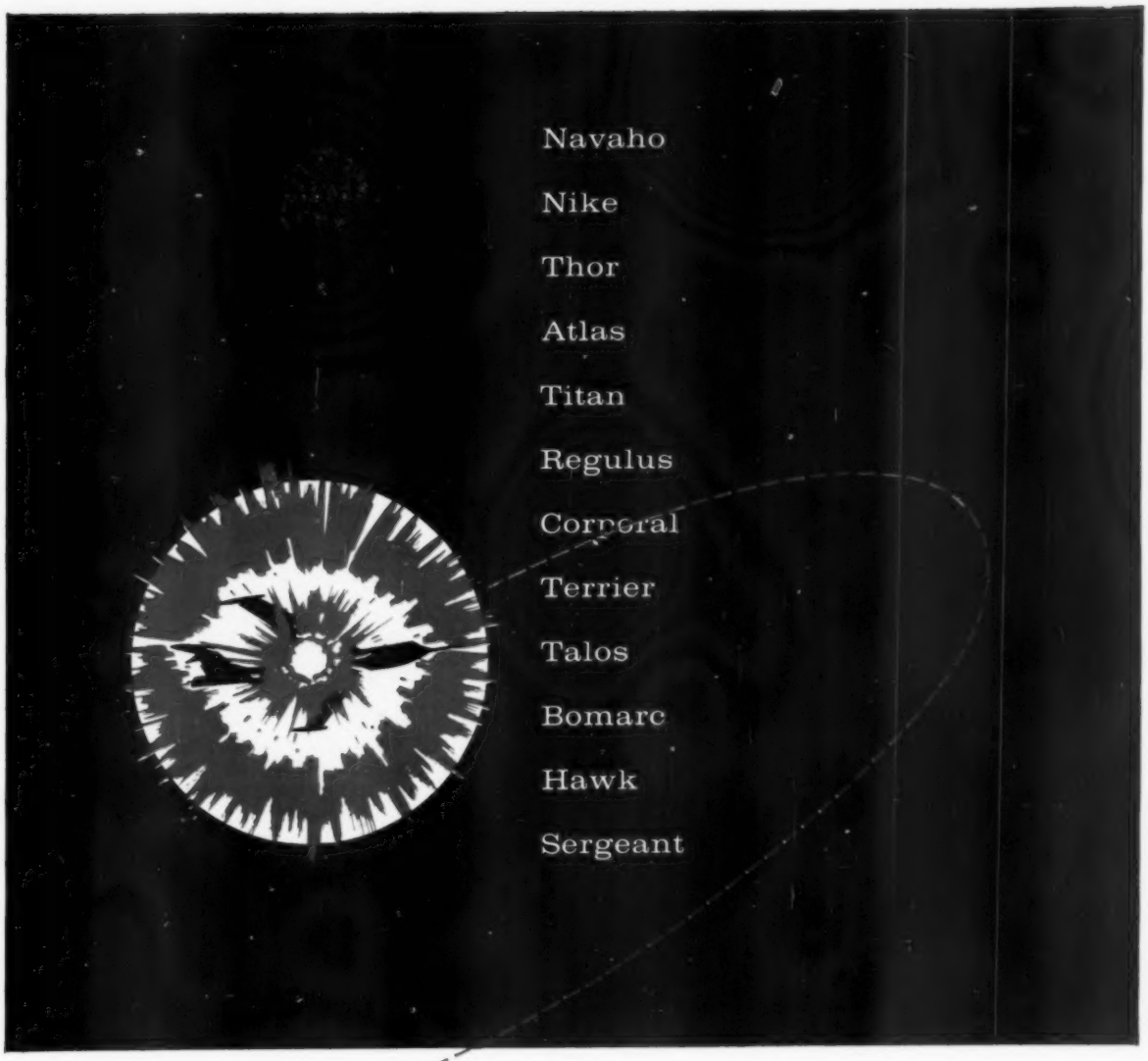

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hydraulic systems for missile handling and launching . . .

Name an important missile. Chances are that Vickers equipment or "know-how" played a part in its success. Every one of the missiles listed above, for example, depends on Vickers hydraulic units for some phase of surface handling, launching or testing.

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There are important reasons for Vickers' success in heavy ordnance work. Long experience in this specialized field is one. Another is the fact that Vickers has the most comprehensive line of hydraulic equipment.

Hydraulics itself has unique advantages. On a recent project, a 100-horsepower transmission offered the ideal solution because of: —

High torque to inertia ratio — the pump end can be stroked from zero to maximum displacement in less than 30 milliseconds.

High power gain — a milliwatt input easily controls hundreds of horsepower.

Very narrow deadband — narrower than any other high horsepower drive.

High horsepower to weight ratio.

For one source convenience and one source responsibility, bring all your hydraulic problems to Vickers.

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Marine and Ordnance Department
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Do you dare tackle tough problems? At Ford Instrument Co., finding the answer to problems is the engineer's prime responsibility. As a result, the engineer who meets this challenge receives the professional and financial rewards his work merits. Our qualifications are high, and we want to be sure you can match the high standards of our present engineering staff. Our projects are too important and too complicated to trust to most engineers. What will you do at FICo? That depends on your specific abilities and experience. For details about the challenge, environment, and opportunity at FICo, write Philip F. McCaffrey at below address.

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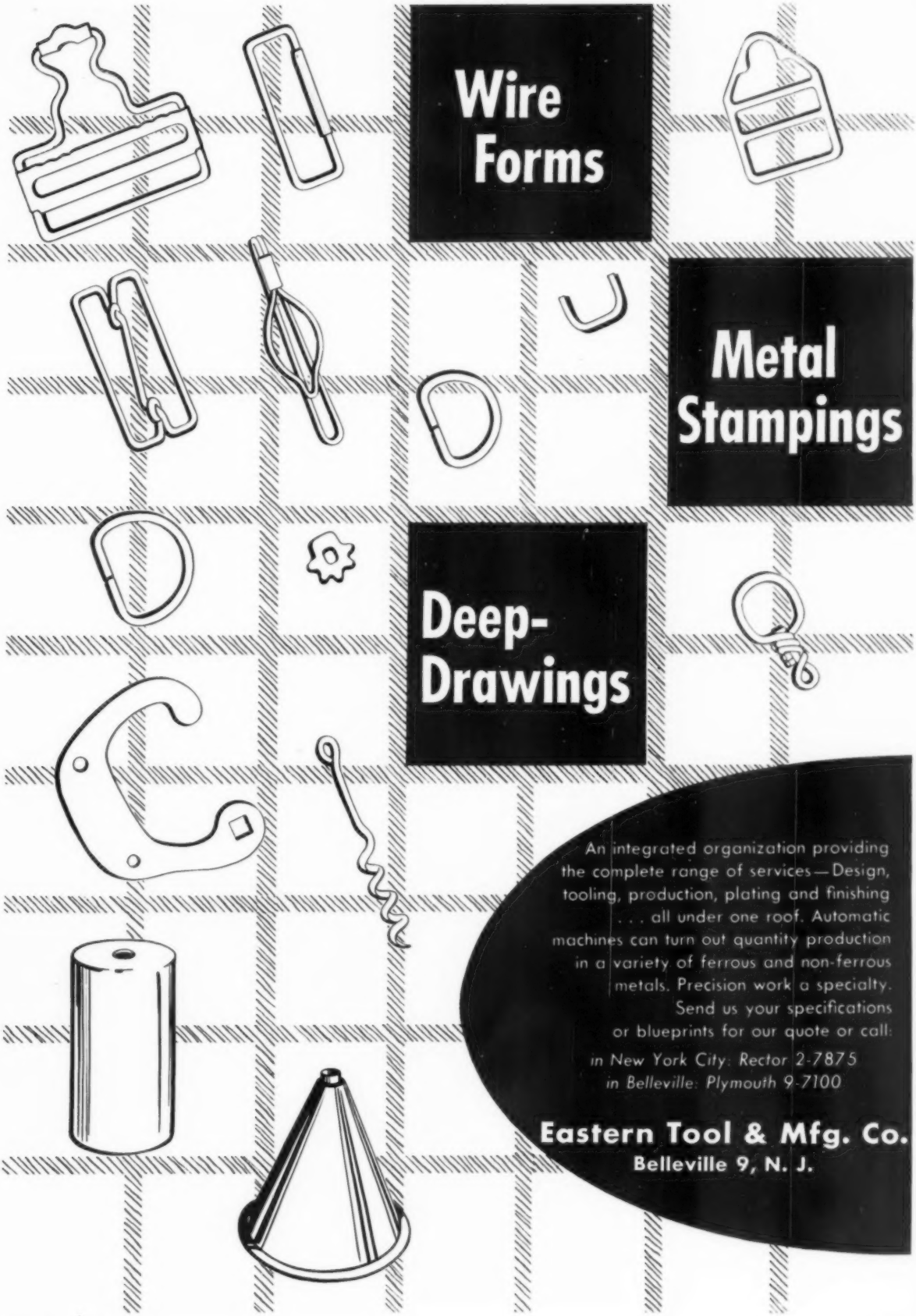

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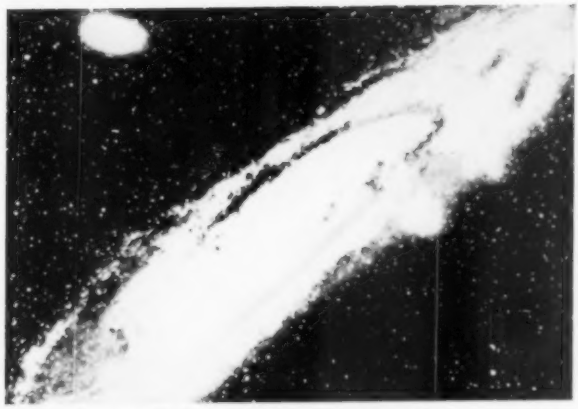
The first men on the moon

What Douglas engineers are doing to make it possible!

Space travel, a dream five years ago, is now so near reality that lunar landings are predicted by the end of this century.

This is hastened by knowledge being gained in *present* and *practical* research. For instance, when Douglas engineers find new ways for fliers to survive high gravitational pulls at supersonic speeds, they also help some future pilot survive the blast-off of a moon-bound rocket. And current studies on heat dispersion, aimed at getting an intercontinental missile back into our atmosphere without air friction burning it up, will apply to the problem of returning a space ship safely to earth.



With the possibility of interplanetary flight accepted by engineers, man now looks to outer space and is speculating on new power sources needed to get him there. A predicted break-through is the plasma engine, which will harness ions or light itself to drive aircraft nearly 186,000 miles per second.

At Douglas, a Missiles Division with the longest history in its field, is building rockets and missiles for military use. Nike Ajax (above) is already guarding principal cities, and soon the more potent Nike Hercules will be ready to take over these assignments. Thor, an intermediate range ballistics missile, is undergoing tests, and on the classified list are many other out-of-this-world projects in engineering, design and construction.

Depend on

DOUGLAS

first in Aviation

Picture of John Wise from AMERICAN HERITAGE

The old lady gave him what for

AN OLD LADY living near Henderson, N. Y. in 1859 was shocked at the way the four men had arrived—and said so. Such sensible-looking men in such an outlandish vehicle!

But John Wise and his crew, perched up in a tree, were far too happy to listen. Caught by a storm, their aerial balloon had almost plunged beneath the angry waves of Lake Ontario. Then, after bouncing ashore, they had crashed wildly through a mile of tree-tops before stopping in one.

Now, his poise regained, Wise stood up to proclaim: "Thus ends the greatest balloon voyage ever made." He had come 1200 miles from St. Louis in 19 hours, setting a record unbroken for 60 years.

He had also proved his long-held theory of an earth-circling, west-east air current—and that was far more important to him. For Wise was no carnival balloonist. He was a pioneer scientist of the air, a man whose inquiring mind and courageous spirit helped start the vast forward march of American aviation.

In America's ability to produce such men as John Wise lies the secret of her real wealth. For it is a wealth of human ability that makes our country so strong. And it is this same wealth that makes her Savings Bonds so safe.

168 million Americans back U. S. Savings Bonds—back them with the best guarantee you could possibly have. Your principal guaranteed safe to any amount—your interest guaranteed sure—by the greatest nation on earth. If you want *real* security, buy U. S. Savings Bonds at your bank or through the Payroll Savings Plan where you work. And hold on to them.

PART OF EVERY AMERICAN'S SAVINGS BELONGS IN U. S. SAVINGS BONDS

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U. S. Army Photo

Experimental rocket being launched from tower at DOFL's Maryland test facility.

ELECTRONIC AMMUNITION THAT "THINKS" IS DEVELOPED AT ARMY'S DIAMOND ORDNANCE FUZE LABORATORIES

Since 1940, scientists and engineers at Diamond Ordnance Fuze Laboratories, with their industrial contractor counterparts, have made important contributions to electronic ordnance. These include the proximity fuze, greatly improved fuzes for antitank and other special ammunition, and, more recently, fuzing systems for guided missiles. Other basic results of DOFL's research and development teams are new electronic systems which increase the accuracy of measurement of distance, velocity and direction, new electronic and mechanical control systems, and new and radical components and materials. DOFL's main laboratory is in Washington, D. C., and it maintains an extensive test facility at Blossom Point, Maryland. Over 1400 scientists, engineers, technicians, and supporting personnel work in these centers.

Electronic ordnance was born in World War II. Ammunition of this type, a DOFL specialty, senses the presence, distance, and direction of a target and causes the warhead to function at the instant when it will inflict the most damage. Electronic control can be compared to having a sharpshooter in every piece of ammunition. The accurate effect is devastating.

Many advances in ruggedness and miniaturization, pioneered by DOFL, are contributing significantly to peacetime technology. Typical industrial products which sprang from ordnance programs are printed electronic circuits, tough and tiny electronic tubes, and rigid mounting of components in solid plastic blocks. These valuable by-products have contributed heavily to the ability of DOFL's industrial teammates to design safer, smaller, and better components.

This is one of a series of ads on the technical activities of the Department of Defense.

FORD INSTRUMENT CO.

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Beverly Hills, Cal. • Dayton, Ohio

Class of technicians at Ford Instrument is instructed on techniques to be employed in assembling equipment for Army Ordnance project.

ENGINEERS of unusual abilities can find a future at **FORD INSTRUMENT CO.** Write for information.

TORQMATIC shifts at full throttle– eases haulers out of muck and mire

THE TERRAIN is rough. Some of the grades are 15% or more. You're hauling 50-60 tons.

So you need TORQMATIC DRIVE.

You need TORQMATIC because it quick shifts at full throttle. No lags or stalls between gears. You need TORQMATIC to eliminate the gearshift guesswork of clash box transmissions. TORQMATIC not only eliminates guesswork – it can increase engine life 47%!

You need TORQMATIC to get loaded haulers out of soft mud and mire quickly without towing.

You need safety, too, the kind of downhill safety TORQMATIC provides with its optional hydraulic retarder. You just pull a lever for slow descents *without riding the service brakes.*

Take a tip from 55 manufacturers of 122 different kinds of road-building and construction equipment. Get the Allison TORQMATIC story.

Ask your equipment dealer or write: Allison Division of General Motors, Box 894W, Indianapolis 6, Ind.

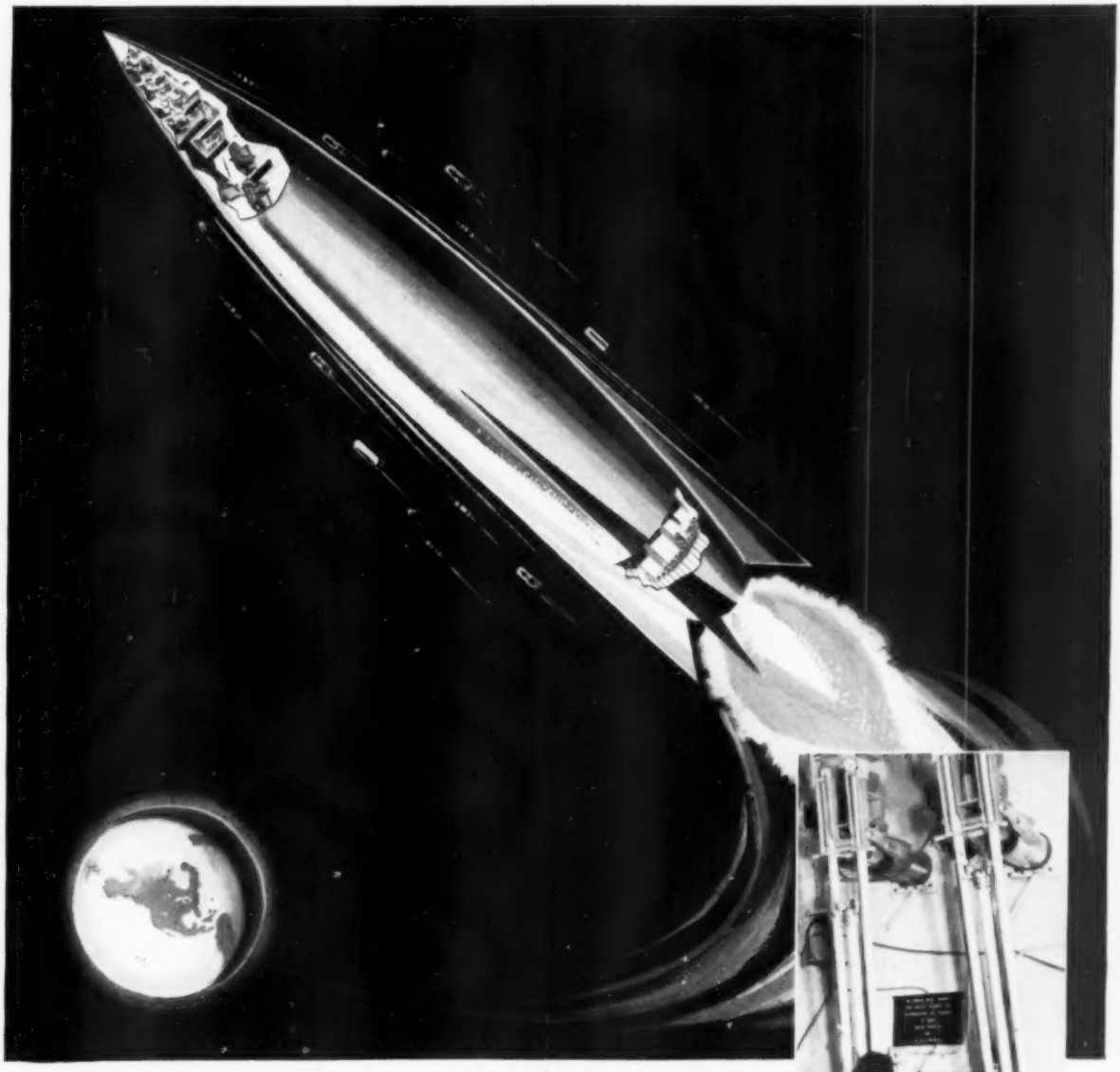
NO. 2 IN A SERIES ON SPEEDING AMERICA'S ROAD-BUILDING PROGRAM

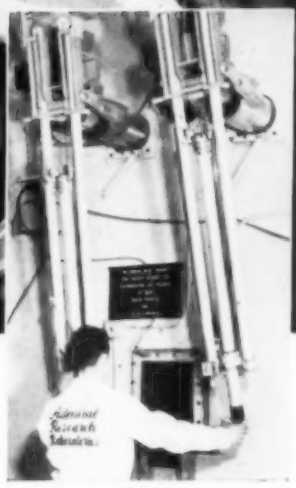
GM TORQMATIC

Allison

TORQMATIC DRIVES

ORDNANCE





Here, in Admiral's Nucleonics Laboratory, radiation tests are conducted with a cobalt 60 source rated at 20,000 curies. The observer is shielded by 41 inch walls of magnetite ore within steel shells, and a 42 inch lead glass window.

Admiral® research

foretells the future of components traveling in outer space

What kind of power will drive man's first vehicle through outer space? It may be an ion propulsion device powered by a nuclear reactor. Ionic drive is now under investigation for the Air Research and Development Command. Investigators recognize the need to shield the human cargo against radiation if a nuclear power source is carried aboard. They also know that efficient design will not permit shielding the space ship's complex electronic equipment.

Then how will electronic components behave when exposed to nuclear radiation? The facts are being established by a continuing study now in progress at Admiral for the U.S. Air Force. This study provides advance knowledge to engineers charged with designing the space ship's electronic complement.

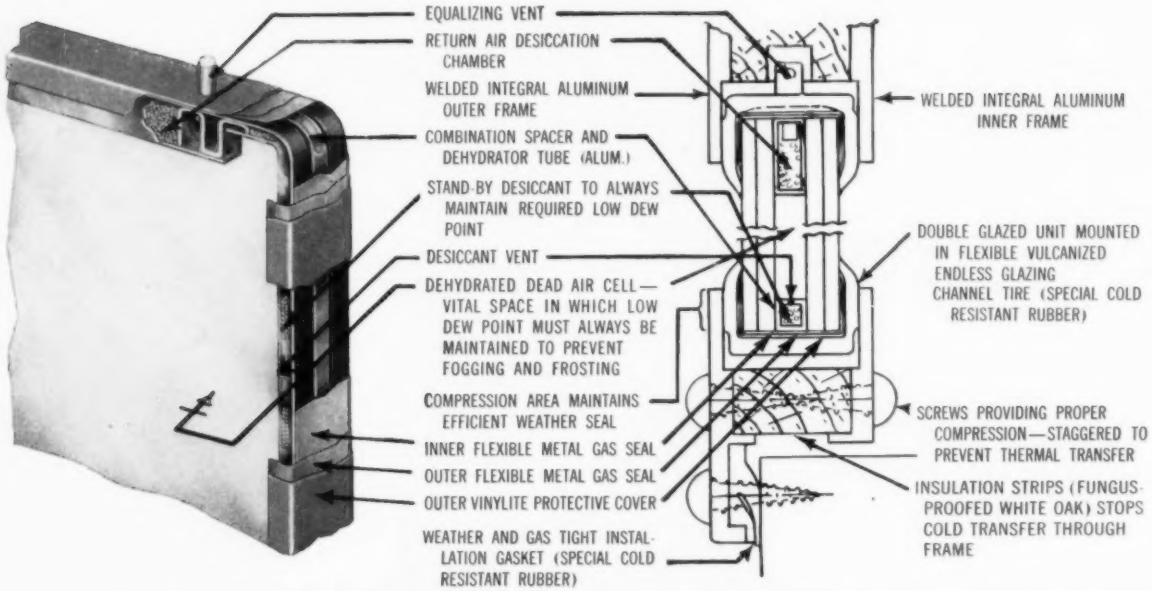
Admiral has equipped a special Nucleonics Laboratory which includes one of the world's largest cobalt 60 sources of gamma radiation. New instrumentation and techniques have been developed for measuring radiation environments. The project furthers Admiral's leadership in the field of fundamental and applied nuclear research. Detailed information is available to authorized persons.

LOOK TO *Admiral* FOR RESEARCH • DEVELOPMENT • PRODUCTION IN THE FIELDS OF: MILITARY TELEVISION COMMUNICATIONS UHF AND VHF • RADAR RADAR BEACONS AND IFF • RADIAC TELEMETERING • DISTANCE MEASURING MISSILE GUIDANCE • CODERS AND DECODERS CONSTANT DELAY LINES • TEST EQUIPMENT ELECTRONIC COUNTER MEASURES

ENGINEERS: The wide scope of work in progress at Admiral creates challenging opportunities in the field of your choice. Write Director of Engineering and Research, Admiral Corporation, Chicago 47, Illinois.

Admiral **CORPORATION • GOVERNMENT LABORATORIES DIVISION • CHICAGO 47**

HIGH EDWARDS ALTITUDE


EQUALIZING VENT
RETURN AIR DESICCATION CHAMBER
WELDED INTEGRAL ALUMINUM OUTER FRAME
COMBINATION SPACER AND DEHYDRATOR TUBE (ALUM.)
STAND-BY DESICCANT TO ALWAYS MAINTAIN REQUIRED LOW DEW POINT
DESICCANT VENT
DEHYDRATED DEAD AIR CELL—VITAL SPACE IN WHICH LOW DEW POINT MUST ALWAYS BE MAINTAINED TO PREVENT FOGGING AND FROSTING
COMPRESSION AREA MAINTAINS EFFICIENT WEATHER SEAL
INNER FLEXIBLE METAL GAS SEAL
OUTER FLEXIBLE METAL GAS SEAL
OUTER VINYLITE PROTECTIVE COVER
WEATHER AND GAS TIGHT INSTALLATION GASKET (SPECIAL COLD RESISTANT RUBBER)
WELDED INTEGRAL ALUMINUM INNER FRAME
DOUBLE GLAZED UNIT MOUNTED IN FLEXIBLE VULCANIZED ENDLESS GLAZING CHANNEL TIRE (SPECIAL COLD RESISTANT RUBBER)
SCREWS PROVIDING PROPER COMPRESSION—STAGGERED TO PREVENT THERMAL TRANSFER
INSULATION STRIPS (FUNGUS-PROOFED WHITE OAK) STOPS COLD TRANSFER THROUGH FRAME

Always Brilliant Vision—NO FOG—NO FROST

At All Altitudes

At Temperatures from +140° to −60° F.

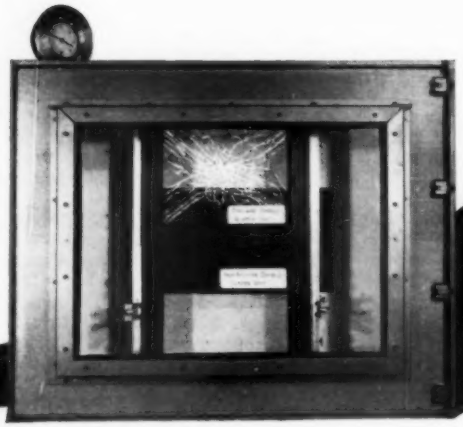
EDWARDS High Altitude

meet severest service requirements for mobile air-borne units

HIGH ALTITUDE TEST

Top window in vacuum chamber, without pressure release system, shattered at the equivalent of 9,000 ft. elevation.

Lower window in vacuum chamber demonstrates the efficiency of the Edwards pressure relief system, permitting the Edwards High Altitude Window to be taken to any altitude and returned to sea level at an ascent or descent rate up to 3000 f.p.m. without impairment of seal, bursting of glass or lowering of dew point in dead air space.



Window Assemblies

AIR FORCE CRASH TRUCK
Edwards windshield with heat resistant glass and regulator drop-type, **high-altitude** window assemblies.

MACHINE SHOP VAN
Edwards **high-altitude,** top-hinged, push-out window assemblies with insect screens and black-out shades.

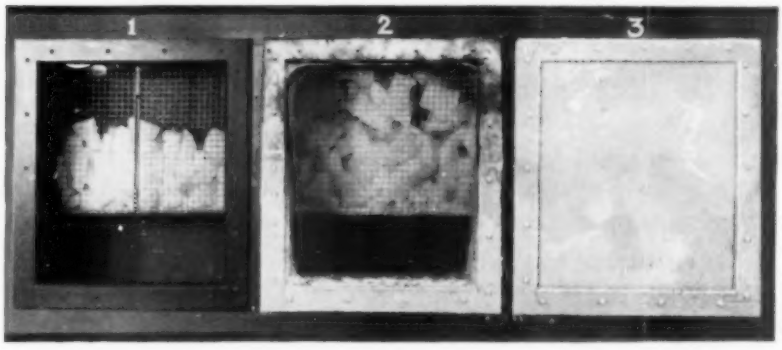
ARCTIC SNOW PLOW CARRIER
Edwards **high-altitude,** heavy-duty windshield (83 x 32) and drop-down window assemblies with regulators.

RADAR-ELECTRONIC SHELTER
Edwards top-hinged, pushout, **high-altitude** windows with inside insect screens and outside blackout shield.

Typical Service Applications

ARCTIC COLD TEST

Here is demonstrated the ability of the Edwards High Altitude Window to insulate against the transfer of heat and cold and provide clear visibility and light transfer at temperatures of —65°F. and lower. Photos left to right: (Fig. 1) Edwards High Altitude Window. (Fig. 2) Standard double-glazed, non-insulated window. (Fig. 3) Single-glazed, non-insulated window. Results of these tests demonstrate and explain why the Edwards High Altitude Double-Glazed Window is widely specified by the armed services in all types of mobile air-borne equipment.



FOR COMPLETE INFORMATION:—

THE O. M. EDWARDS Company,
Syracuse, N.Y.

New York Office:
50 Church St., New York 7, N.Y.

THE EYES OF TRANSPORTATION

L-26 L-26B L-26C

THREE GREAT COMMANDERS

IN THE SERVICE OF THE U.S. ARMY

A PREVIEW OF PROGRESS

Since its beginning, Aero Design & Engineering Co, manufacturer of the L-26, L-26B and L-26C, has produced high-speed twin-engine executive transports as a privately-financed enterprise. Construction of a new factory is underway now and will be completed this year on a newly-acquired 44-acre tract. This additional acreage will provide for future growth and continued service to Military and Business—another outstanding example of American Free Enterprise at Work.

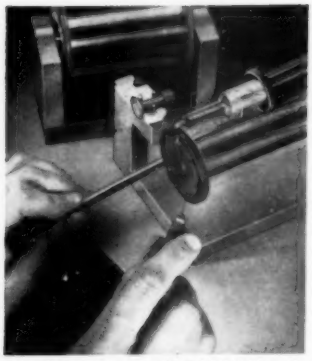
The choice of men at the top

AERO Commander

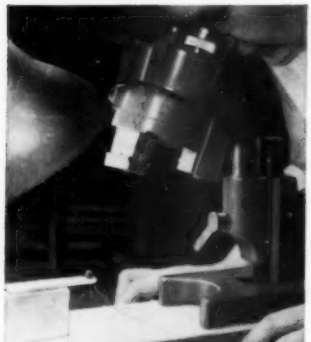
AERO DESIGN & ENGINEERING CO

TULAKES AIRPORT • P O BOX 118 • BETHANY, OKLAHOMA

YOU'RE LOOKING AT A WIRE SO SMALL IN DIAMETER IT'D TAKE 6 OF THEM TO MAKE A HAIR ON YOUR HEAD



It takes a pair of skillful hands to charge the point of this tiny soldering iron with just enough solder to bind the ends of the wire to the posts.



Inspector looking through binocular microscope is checking an Ordnance Squib. Each one must get this visual as well as electrical resistance test. This nichrome wire, used in Ordnance Squib, is .0005 of an inch in diameter.

You're looking at an ORDNANCE SQUIB or electric detonator developed for the firing mechanism of a new rocket. Interesting thing about it is the bridge wire between the posts. In the photo, the squib is magnified 50 times. Even then you can barely see the wire. It's 1/6 the diameter of a human hair.

This ORDNANCE SQUIB was developed by the prime contractor's research division. Ours was the job of mass-producing it. We had to start from scratch. Tolerances were all the contractor could give us. And they are very critical. To give you some idea, the nichrome wire is .0005 of an inch in diameter. The entire length of the bridge is only .150 of an inch. Within this short distance, the ends must be soldered to the terminals. The slightest travel of solder from these anchoring positions would vastly change the electrical resistance. This has to be held to 9 ohms. This was the order and it had to be filled in full, on time, and according to specifications.

To make a squib is, of itself, no particularly difficult job. To make it in vast quantities, within the narrow tolerances required, is something else. This is where Perry Plastics went to work.

First of all, equipment to mass-produce the piece had to be developed. Second, personnel to handle the equipment had to be trained. Happily both assignments were accomplished within the framework of Perry Plastics' team. Actually, the work is done by hand, under binocular microscopes. For mass-produced pieces, this requires a remarkably high degree of skill. All of the equipment is in place on Perry's production line. It is in daily use making ORDNANCE SQUIBS and other items with critical tolerance for defense as well as for civilian use.

The applications of plastics are as wide and varied as American industry itself. And every day, new uses are being found for this most versatile of materials. Perhaps you've a part that would do a better job if it were made of plastics, or a plastics part that could be made cheaper and better. Whatever the problem, your requirement will get the same kind of action as Perry gave to this Ordnance assignment.

Meanwhile, write for a free booklet that tells you more about Perry Plastics' capacity and how it might be put to work for you.

PERRY PLASTICS, INC.

ERIE, PENNSYLVANIA

THE FLIGHT HEARD 'ROUND THE WORLD

Recently three B-52 bombers flew around the world in 45 hours and 19 minutes. They were only specks in the vastness of the sky, yet they were in voice-contact every mile of the way—with SAC headquarters in Omaha, with each other, with bases along the route and with the KC-97 tankers that refueled them in the air.

Their speed-of-light contact was the AN/ARC-21 liaison communications set in each of the ships. This is a long-range, pressurized, high-altitude airborne system, capable of world-wide communications. It may be operated by the pilot, so no radio operator is needed. It is characterized by minimum training requirements, simplified maintenance, high reliability, positive channel selection —with a choice of any 20 of 44,000 frequencies.

In this as in other ways, RCA serves our Nation's armed forces. RCA scientists and engineers are constantly creating, designing and producing new and better electronic systems and equipment.

RCA

Tmk(s) ®

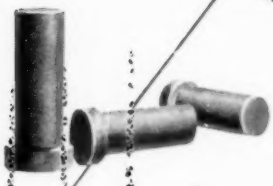
RADIO CORPORATION of AMERICA

DEFENSE ELECTRONIC PRODUCTS — *CAMDEN, N. J.*

AIRCRAFT QUALITY

ALLOY CASTINGS

...for the special requirements of your industry



METALS PROCESSING DIVISION FOUNDRY handles wide range of sizes, closely controls dimensions

Precision testing methods provide close control of casting quality

Curtiss-Wright's Metals Processing Division today offers your industry precision castings of critical parts in a wide variety of sizes, and with closely controlled dimensions. For example, in the large casting shown, tolerance is ±.030 over 36″ diameter. From its modern, completely equipped foundry in Buffalo, the Division supplies heat, corrosion and abrasion resistant castings from a full range of special-property alloys, including ductile iron...by sand, centrifugal, ceramic or shell processes.

Precision alloying techniques, modern melting controls with spectrometer testing, X-ray control by experienced radiographers – all add up to castings with superior physical and mechanical properties . . . mean better and more dependable products for the critical needs of industry. Qualified design engineering assistance is a part of the comprehensive Metals Processing Division service. Write for details.

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METALS PROCESSING DIVISION
CURTISS-WRIGHT
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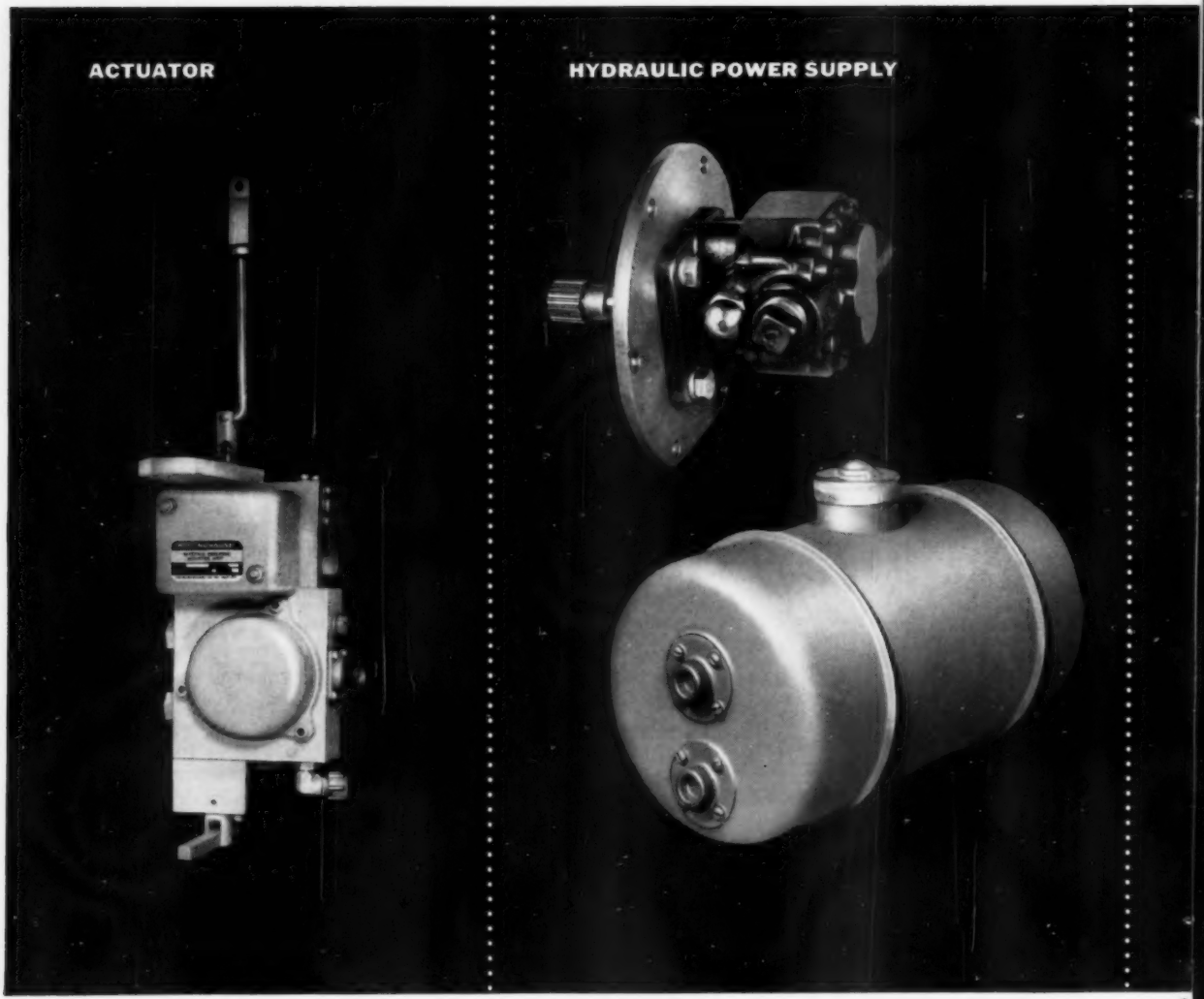
Opening the way to new engine control accuracy



Westinghouse electric governors actually predict speed changes . . . react faster than any other

Now, Westinghouse offers the fastest acting electric governor in history. It senses electrical load change . . . anticipates speed change. It is much faster acting than the conventional governor which must wait for actual speed change.

The Westinghouse electric governor also provides for automatic isochronous load sharing by two or more engine-generator sets. Electric frequency (speed) sensing, another prime feature in the Westinghouse electric governor, eliminates the need for expensive and troublesome mechanical speed-drive systems.

This accurate, dependable governor is easy to maintain . . . no tubes or other frail parts . . . operator attention is cut to minimum.

FOR ALL THE FACTS, write Westinghouse Electric Corporation, 3 Gateway Center, Pittsburgh 30, Pennsylvania. Ask for B-6757. J-22047

YOU CAN BE SURE...IF IT'S Westinghouse

ROCKET POWER!

$$I_{sp} = \frac{1}{g}\sqrt{2gR\frac{T_c}{M}\frac{\gamma}{\gamma-1}\left[1-\left(\frac{p_e}{p_c}\right)^{\gamma-1/\gamma}\right]}$$

If you're working in **SOLID PROPELLANTS...**

EXOTIC OR CONVENTIONAL, TRONA* OFFERS YOU THE ONLY BASIC SOURCE OF ALL FOUR OF THESE OXIDIZERS GIVING VERSATILITY AND SELECTIVITY TO YOUR ROCKET CHEMISTRY APPLICATIONS.

LITHIUM NITRATE
LITHIUM PERCHLORATE
AMMONIUM PERCHLORATE
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Whether your particular need is for one of the more conventional oxidizers or for the specific impulse potential of lithium perchlorate, you will benefit from American Potash & Chemical Corporation's basic and applied research, development and production of solid propellant oxidizers for the rocket and missile fields. There are advantages for you, too, in AP&CC's experience in propellant technology and the general capabilities of high-energy solid fuel systems. To answer your questions concerning the properties, availability and performance of our complete line of rocket components, we suggest you write or phone one of the offices listed below.

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American Potash & Chemical Corporation

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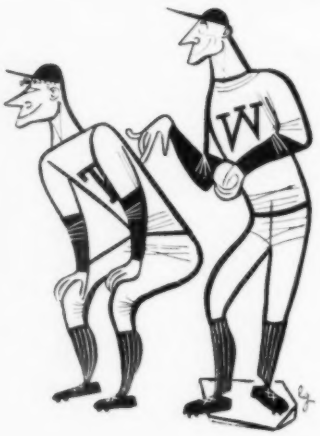

don't get caught **OFF BASE**

The outcome of another war will be determined by lead time more than any other factor. Members of the American Ordnance Association realize this and are constantly working to devise means for improving and speeding up armament design, development, and production. As a member, you help keep America and your company from being "caught off base."

AMERICAN ORDNANCE ASSOCIATION

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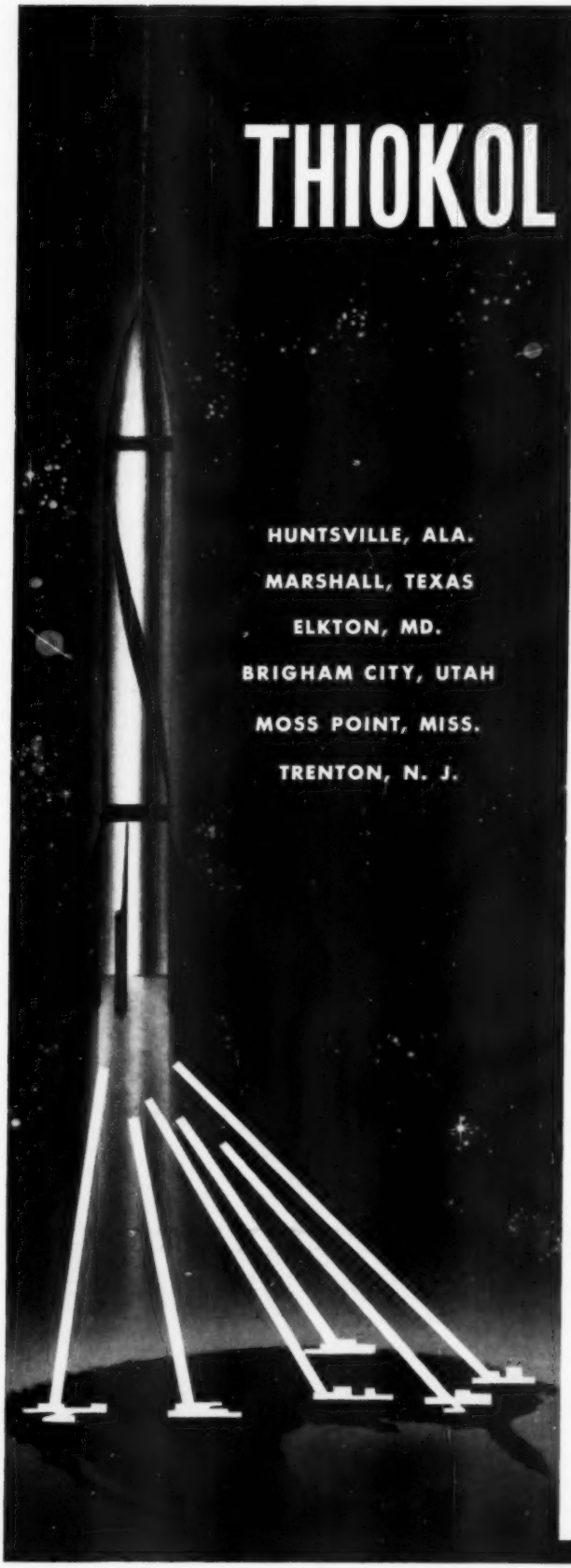

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Across the nation, the research and manufacturing facilities of the Thiokol Chemical Corporation are serving the needs of the rocket industry.

The versatility, ruggedness and power of THIOKOL rocket engines have been demonstrated by the **FALCON**, the **NIKE HERCULES**, the **LACROSSE**, the **NIKE-CAJUN**, the **X-17**, and the mighty booster for the **MATADOR "B"**.

If you are a mechanical, electronic, chemical or aeronautical engineer, a chemist or physicist interested in joining the growing field of solid propellant rocketry send your inquiry to: **THIOKOL CHEMICAL CORP.**, Redstone Div., Huntsville, Ala.; Longhorn Div., Marshall, Texas; Elkton Div., Elkton, Md.; and Utah Div., Brigham City, Utah.

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SEA-LAND SERVICE
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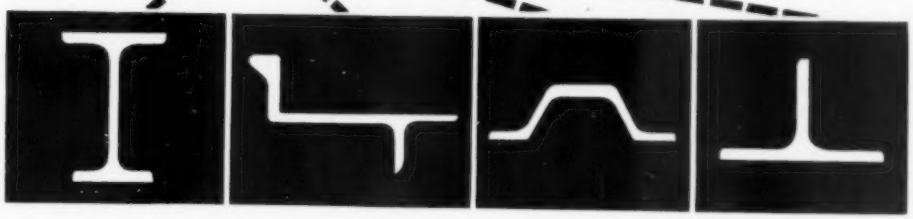
Down to the sea in "fishyback" trailers, made with Flynn aluminum extrusions

Now it's truck delivery to any part of the western hemisphere! Fully loaded trailers, specially built for the tough job, are lifted bodily on shipboard and transported to the destination shore. No re-loading, no extra handling for ocean shipments.

The rugged framework of the "Fishyback" trailers shown here consists of four close-fitting extruded aluminum shapes by Michael Flynn. Strong enough to carry the full weight of the loaded trailer while being hoisted aboard, millions of pounds of these and similar Flynn extrusions are being produced for Fruehauf and other leading trailer makers.

What Flynn is doing for "Fishyback" shipping, Flynn can do for you. If your requirements are for quality extrusions of stock or custom profile, in any quantity, you can rely on Flynn for prompt delivery to your specifications. And advanced Flynn aluminum metallurgy assures you alloys and profiles of maximum strength with minimum weight.

Find out for sure—call Flynn on your next aluminum extrusion order, large or small.



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Extrusion Division

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FLYNN
EXTRUSIONS

AiResearch MISSILE AUXILIARY POWER UNIT

Compact, reliable system features high output with simplicity of design

SPECIFICATIONS:

Output: 650 watts, 5000 cycles, 115 volts, single phase
35 watts, 400 cycles, 115 volts, single phase
0.6 gal. per min. at 2000 psi hydraulic pressure

Regulation: ± 5% voltage and frequency

Duration:	27 seconds
Weight:	9.5 pounds
Size:	6.14 in. diam., 6.74 in. long

Ground power: compressed air

This AiResearch auxiliary power package operates the vital electrical and hydraulic systems in a missile.

Gases from a solid propellant spin the unit's turbine wheel at 50,000 rpm. The turbine's shaft drives the following: a 650 watt generator which supplies electrical power to run the missile's guidance system; a 35 watt generator which runs the missile's gyros; a hydraulic pump which in turn powers the servos that control the movable flight surfaces of the missile's airframe.

The hydraulic system features drilled passages which eliminate the need for potentially troublesome plumbing. It includes reservoir, filters, temperature compensator, relief valve, check valve, and squib valve within a single housing.

This auxiliary power system is an example of AiResearch capability in the missile field. Inquiries are invited regarding missile components and sub-systems relating to air data, heat transfer, electro-mechanical, auxiliary power, valves, controls and instruments.

Outstanding opportunities for qualified engineers

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AiResearch Manufacturing Divisions

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KEEP AMERICA STRONG FOR PEACE

Introduce your friends to the A.O.A.

Many of your friends, who also have a strong interest in national preparedness, would be anxious to take advantage of A.O.A. membership if they knew more about our Association.

Why not tell them how the Ordnance Association works for the national defense along with our armed forces . . . and how their support of the A.O.A. can really help.

At the same time, be sure to explain the benefits and services of membership, including ORDNANCE magazine, THE COMMON DEFENSE newsletter, INDUSTRIAL PREPAREDNESS, and LOGISTICS—the world's leading publications on ordnance and armament preparedness.

Better yet, send a friend this page and tell him of the personal satisfaction you derive from A.O.A. membership.

APPLICATION FOR MEMBERSHIP

American Ordnance Association
708 Mills Building
Washington 6, D. C.

I hereby apply for individual membership in the American Ordnance Association and enclose annual dues ($4 for one year, or $10 for three years) which include all publications of the society and all other membership privileges.
I certify that I am a citizen of the United States.

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COMPANY ..... **POSITION** .....

Recommended by .....

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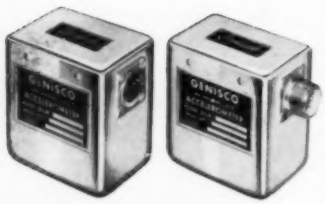


Model GLH

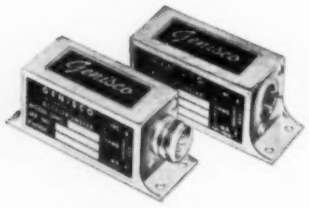
A rugged magnetically damped instrument with low natural frequencies for low range. High-quantity production assures good price and delivery schedules. Available in ranges from ±1 G to ±30 G.

Model DDL

Magnetically damped low-range instrument available in ranges from ±1 G to ±30 G. Ultra-sensitive models supplied as low as ±0.1 G. Certified to MIL-E-5400 and MIL-E-5272A. Especially good in severe shock and vibration applications. An acceleration-sensitive switch version of the DDL is designated as the Model DDS.

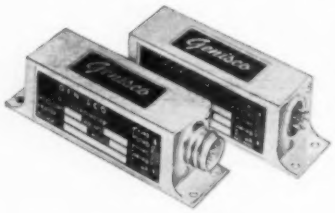
Model GAL

Incorporates a variable transformer a-c output with the magnetically damped sensory mechanism of the proven Models DDL and GLH. Superior reliability, life, resolution, and sensitivity. Available in ranges from ±1 G to ±30 G. Range as low as ±0.1 G also obtainable.



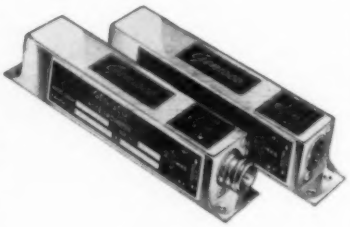
Model GMO

A rugged, miniature, viscous-damped instrument with ranges from ±2 G to ±30 G. Unbalanced-range instruments also available. Medium high natural frequencies.



Model GMT

Basically a Model GMO with internal thermostat-operated heater, assuring maximum environmental stability within the instrument. Damping remains constant with change in ambient temperature.



Model GDM

Miniature double-potentiometer instrument capable of sensing lateral acceleration in two mutually perpendicular planes (e.g., pitch and yaw). Ideally suited for missile and high-speed aircraft flight control systems.

NEW! GENISCO ACCELEROMETERS NOW GOLD PLATED FOR GREATER RELIABILITY

CASES GOLD PLATED INSIDE AND OUT—This new trend in instrument plating has two important advantages over tin plating or fusing. Being the least active metal, gold prevents the formation of crystalline "whiskers" inside the case which could reduce performance and even cause malfunction. Gold plating also assures positive protection against corrosion to the exterior of the case and, because of its excellent solderability, makes possible a more reliable hermetic seal. The new gold plating is available on *all* models at *no extra cost.*

Descriptive data sheets available on all models.
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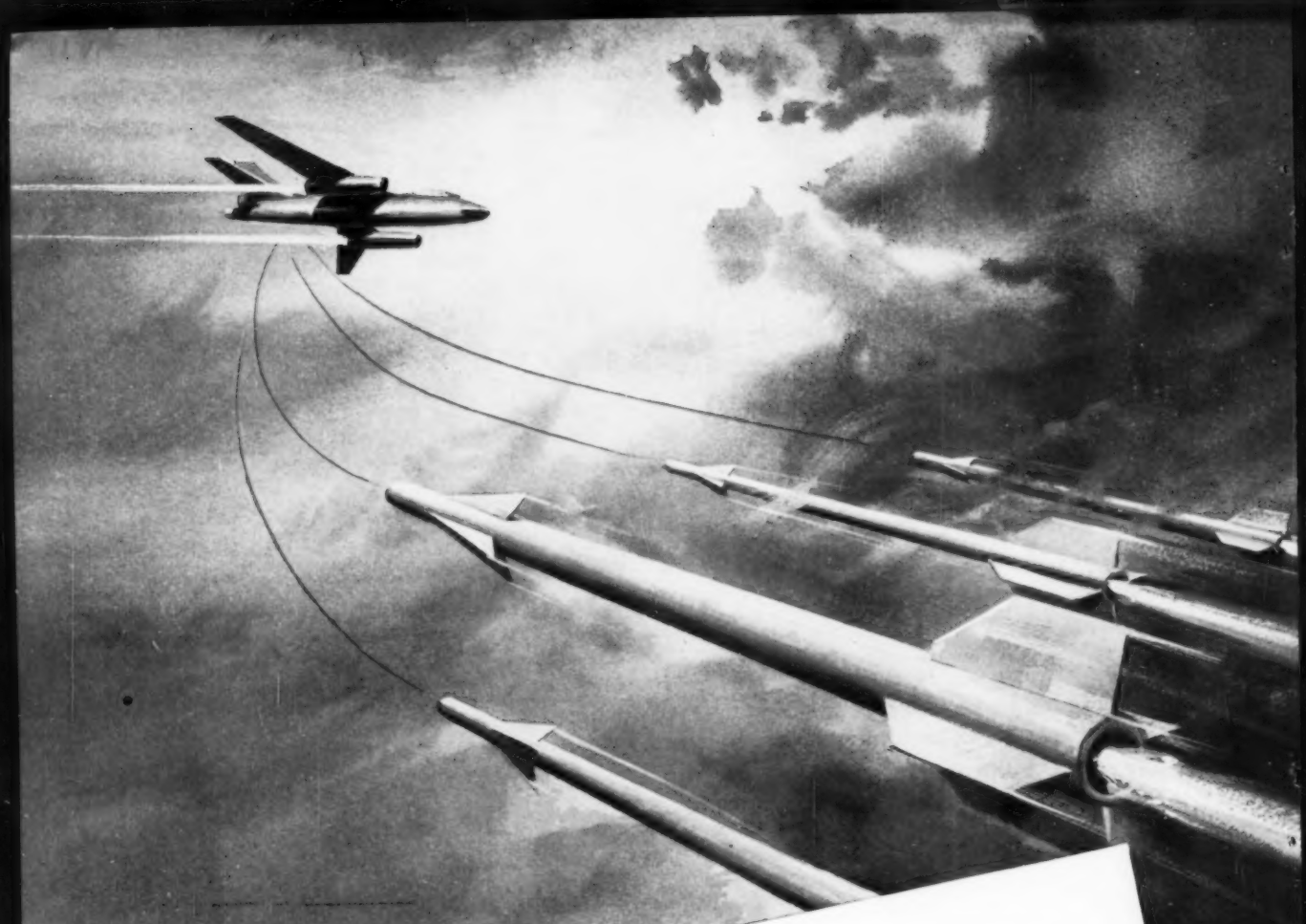

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This section of ORDNANCE contains selected papers on armament technology presented at meetings of Technical Divisions and Committees of the American Ordnance Association and contemporary articles on armament research, development, manufacture, and field use

Ceramic Cutting Tools

Sintered alumina tips help to eliminate strategic tungsten and cobalt

W. B. Kennedy

Ordnance engineer, Watertown Arsenal, Watertown, Mass.

AT the close of the first year of World War II, carbides controlled all metal-cutting operations at Watertown Arsenal. These cutting tools contain percentages of strategic tungsten and cobalt in small blanks that can be brazed or clamped in soft steel shanks.

During the early part of the Korean war, many new high-temperature alloys were invented for use in jet engines and other similar applications. The Government's jet-engine materials policy, respecting the conservation of critical materials used in jet engines, implies that optimum efficiency must be obtained in the use of the designated materials in the manufacture of jets. The designated materials include cobalt, tungsten, nickel, chromium, and molybdenum. No impairment or reduction in performance of jet engines should result from conservation efforts.

These jet alloys contained high percentages of strategic material, primarily cobalt, which resulted in sintered carbide cutting tool material being exceedingly difficult to procure, and Watertown Arsenal often was forced to resort to high-speed steel cutting tools.

To prevent a repetition of this condition, the Government initiated an investigation for an alternate for conventional cutting tools, and the project was assigned to the Rodman Laboratory at Watertown in March 1954. About this time, reports were made available concerning work being performed in the Soviet Union with a glass-bonded ceramic material called "Mikrolite," so it was decided to investigate the possibilities of utilizing ceramic material processed at the Rodman Laboratory.

The need for the development of nonstrategic materials such as ceramics for metal-cutting purposes has been thoroughly discussed previously. To summarize these objectives, sintered alumina was investigated because it possessed properties which approached those found in carbide tools pertaining to hardness, abrasive resistance, etc., and the material is readily available within the continental limits of the United States, is readily processed, and is nonstrategic in nature. The material also is capable of machining at high velocities with good tool life.

FROM the earlier reporting work there developed considerable interest both in government and industry which resulted in a markedly increased effort toward achievement of the initial goal. There are currently a number of companies in the position to supply ceramic cutting tools, and work at Watertown Arsenal is continuing to include an evaluation of ceramic cutting materials appearing on the market to establish parameters for the applica-

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tion of ceramic tools to production, and the development of "alloyed" ceramics with the view of producing improved materials for cutting-tool purposes.

Basically, powdered-metallurgy techniques have been employed and the necessary firing kilns constructed. A high-velocity turret lathe, fully instrumented to measure cutting-tool forces, was procured to assist in the continuing development studies.

The materials that have been successfully machined with ceramic tools include medium-carbon and alloyed steels, cast iron, hard brasses, aluminum, and, to a limited extent, some of the high-temperature alloys. The steels have been machined in the Rodman Laboratory at speeds up to 1,600 surface feet per minute with feeds of from 0.007- to 0.30-inch per revolution. The General Electric Company reports cutting speeds of 7,000 surface feet a minute, 75,000 inches before regrind. The rotational speed was limited because of the limitations of the engine lathe utilized in the exploratory work.

THE high resistance to abrasion of these ceramic tools was brought out during the machining of a 5-inch-diameter, low-alloy, cast-iron bar. The ceramic tool machined the abrasive scale without difficulty. A modification was made on the 7-degree land by grinding a 45-degree by 1/32-inch bevel from the depth of cut back to the entire cutting edge to combat the abrasive scale.

A sand spot, approximately ¾-inch across and about ½-inch deep also was machined off without the usual difficulties experienced in machining sandy castings with conventional cutting tools. The sand spot made no impression on the cutting edge of the tool, and there was no evidence of "bumping" in the lathe cross slide. This discovery in itself would be enough to promote interest in ceramic tools since it solved a problem long encountered by supervisors in the machine shops.

The question sometimes arises as to the feasibility of utilizing ceramic tools for machining aluminum. A definite suspicion existed that attempting to machine aluminum with an aluminum-oxide cutting tool would result in mutual solubility.

Limited tests at Watertown Arsenal have disclosed that 3-S aluminum can be machined successfully. The chip-breaker platform should be of substantial width, at least 1/8-inch, to prevent "bunching up." The increased width of the chip breaker improves cutting performance and produces the desirable ¾ curled chip. Examination of the hold-down clamp disclosed mechanical bonding of the aluminum to the carbide chip breaker. The seizure however, proved to be entirely mechanical and was easily knocked off with light tapping.

"Considering the number of requests submitted to the Rodman Laboratory by industry regarding the performance of ceramic tools on high-temperature alloys, it appears that the satisfactory machining of such alloys remains a national problem."

A lustrous superficial coating of aluminum on the cutting platform signified either some slight solubility between the chip and the cutting tool or a superficial film caused by surface roughness of the ceramic tool. Side rake controls optimum cutting performance with aluminum and can be from 15 to 20 degrees. It is difficult to avoid some seizure of the aluminum to the cutting tool with any type of cutting-tool material. There are several good cutting oils on the market that can be used to prevent seizure.

Ceramic tools perform well when machining oilite bearing material.

Good results also are obtainable with diamond tools, but since these tools are expensive it may be that the ceramic tools provide a low-priced substitute.

TO date, machining titanium with ceramic cutting tools has proved a problem at Watertown Arsenal. Examination of the cutting tool revealed deep gouging in the vicinity of the nose radius. These gouges, although resembling cratering, were actually chipped out. Previous published work on the machining of titanium has pointed out that the titanium chip does not "spread" like other metals at the tool interface during machining. In other words, there is a high stress concentration at a small area of the cutting tool.

It may be that this pressure exceeds the tensile strength of the ceramic. The material utilized in these tests was high-strength alloy titanium. Experimentation is continuing, but as yet no significant results are ready for release.

Several of the high-temperature alloys have been submitted to the Rodman Laboratory for the purpose of evaluating the machining characteristics of ceramic tools on these types of material. Some of these alloys are of high hardness level (R_c57) while others can be readily filed, but their high strength presents a problem. Ni-Hard has been successfully machined with moderate depths of cut and feed at speeds ranging from 85 to 300 surface feet. Other high-temperature alloys have shown machining characteristics closely resembling those of monel metal.

CONSIDERING the number of requests submitted to the Rodman Laboratory by industry regarding the performance of ceramic tools on high-temperature alloys, it appears that the satisfactory machining of such alloys remains a national problem.

Available reports pertinent to high-velocity machining point out that grain distortion on the workpiece surface is considerably reduced at machining speeds in the vicinity of 1,500 surface feet a minute and higher. The workpiece surface is, therefore, greatly reduced in tensile strength and the cutting action is actually in the state of plastic flow. It may be that this phenomenon will prove an asset to impact machining applications such as milling and other types of interrupted cutting.

In studying clearance angles selected by the various manufacturers for ceramic throw-away cutting tools, it will be noted that they vary from 3 to 8 degrees. Evidently the optimum tool geometry for general-purpose machining may not be finalized readily. We are dealing with an entirely new type of cutting-tool material, and the natural tendency to duplicate the tool geometry suitable for carbide cutting tools may not be the correct approach.

It is difficult for the mechanical group at Rodman Laboratory to understand why ceramic cutting tools are claimed to be limited to light cuts and fine feeds, when experimental work at Watertown Arsenal has shown ceramics to be capable of machining steel at ½-inch depth of cut with a 0.010-inch feed. Such depths of cut, however, can only be at-

tempted on heavy-duty type machines where speed must be sacrificed.

High rotational speeds with light depths of cut can be attained by several of the carbide grades now on the market. Industry, however, is much more interested in roughing operations in which metal is "hogged out," since this particular operation often determines the cost per piece. It is the opinion of the mechanical group at Rodman Laboratory that finishing time in many cases is limited only by the speed of the machine, even with conventional cutting tools.

THE question has arisen as to the advantages and disadvantages of employing coolant with ceramic cutting tools. Coolant could be of assistance in preventing distortion of the workpiece if this were a major problem. The tools themselves, because of their low thermal conductivity, machine satisfactorily at high speeds and produce good surface finish without the aid of coolant.

When employing coolant at high rotational speeds, considerable splashing results, and special shields are required to protect the operator. Splashing also prevents visual observation of what the cutting tool is doing. It is for this reason that coolant was not used in the experimental work at Watertown Arsenal. The low thermal shock resistance of ceramic material would necessitate a constant voluminous flow which could not be stopped or diminished until the machining pass was completed.

It is possible that, when applying coolant to ceramics of high porosity, the pores are filled with the coolant which in turn is transformed to steam and introduces stress concentration that could result in fracturing of the ceramic tool bit. During the exploratory work with ceramics of high porosity, many failures were experienced that could have been caused by the previously stated theory. A high-speed jet system for cooling cutting tools has been designed and assembled in the arsenal and is similar in design to the high-speed systems now under experimentation in commercial industry.

In this system the coolant is fed in a direction so that the jets strike the cutting edge at the tool-chip interface at a pressure of 1,000 pounds per square inch. The jets are fed in thin streams through orifices of approximately 0.010-inch diameter. Each orifice controls a depth of cut up to 1/16-inch, and the unit is designed to cover depths of cut up to 3/16-inch.

Since bottom feeding is the optium method for cooling cutting tools, it is believed that the jets will escape the umbrella effect caused by chips when coolant is applied overhead. This should be a step in the right direction in preventing the brittle ceramic tools from being subjected to thermal shock.

Ceramic tools are definitely not a "cure-all" for difficult tooling problems, but the high rotational speeds attainable with ceramic cutting tools in straight turning or high-speed boring operations, plus the fact that they are composed of nonstrategic materials, makes them an important addition to the metal-cutting field.

One of the remarkable characteristics of these aluminum-oxide materials is their resistance to cratering which is not detectable even after a considerable volume of metal has been removed from the work.

This resistance to cratering is attributed to the extremely low affinity for metals which also accounts for the difficulty experienced in attempting to braze ceramic cutting tools to steel shanks.

Previous reports from Watertown Arsenal have stated that best results in grinding were obtained with diamond wheels. Grits of 150 for roughing and 220-320 for finishing are recommended. When utilizing silicon-carbide wheels, difficulty was experienced in producing a clean cutting edge free from nicks. It has been reported, however, that some commercial facilities obtained satisfactory results by finishing the grinding operation with 420 grit silicone-carbide wheels.

IT is common knowledge that caution must be exercised in grinding sintered carbide material. In the case of fixed grinding, grinding passes exceeding 0.001-inch can cause fine cracks or possibly complete fracture. Several of the ceramic materials submitted by industry have successfully resisted cracking at depths of feed ranging from 0.025- to 0.045-inch per pass. Examination under a 10-power magnifier revealed no evidence of cracks.

In subsequent machining operations in comparison with lightly ground tips there was no evidence of a variation in tool life. This appeared to substantiate a previous statement by Rodman Laboratory personnel that various degrees of hardness in ceramic cutting tools were not of major significance.

Because of the high interest stimulated by work done at the Watertown Arsenal, a full evaluation program was started to determine ceramic tool potential. Ceramic tool blanks were supplied to a number of companies for evaluation of machining performance in their own shops. Initial reports from coöperating companies told of successful turning of a number of materials at speeds far beyond those used with tungsten carbide. Superior finish, excellent size control over long workpieces, and good tool life were other benefits reported.

THERE is every reason to expect that in the future the cutting qualities of ceramic tools will be increased still further through improvements in the technology and chemical compositions of ceramic materials. It is evident, also, that by this means it will be possible to achieve further increases in the mechanical strength characteristics of ceramic material which, for the present, limit the application of ceramic tools to finish and semifinish operations. These problems should be solved through the future joint efforts of specialists in metal cutting and in the technology of ceramic material.

The question has been raised whether ceramic tooling will replace carbides or other tooling available to industry. It is my firm belief that ceramic tooling will augment rather than replace existing tooling. In addition, it should assist in the wider application of ultra-high-velocity machine tools.

It is apparent there is a need for an educational program before ceramic tooling can be properly introduced in production shops. Such a program would be parallel to that established for the introduction of carbide tools in industry many years ago.

Editor's Note.—This article was given as an address before a recent meeting of the Metal Working Lubricants Committee, A.O.A. Advisory, Technical and Research Group, held at Olmsted Air Force Base, Middletown, Pa.

Armament Data Reduction

The Air Force Armament Center, by converting the information received from weapons tests into usable form, prevents progress from becoming hopelessly mired in prohibitively expensive trial-and-error development

Maj. Gen. Edward P. Mechling

THE most mechanically or electronically complicated weapon ever invented or planned for the future is no better than the crossbow unless its performance is predictable. Similarly, the most destructive explosive material is no better than the arrow unless it can be delivered to exactly the right place at the right time.

The Air Research and Development Command's Air Force Armament Center has as its primary mission the testing and development of air armament to meet present and foreseeable requirements as to reliability, applicability, and capability.

One of the most important elements in this mission is evaluative testing of developmental items under conditions approximating those to be encountered in tactical use. This is accomplished by operating the test items and observing their characteristics photographically and electronically with the information being recorded for analysis and evaluation. Raw data records secured in the testing programs are translated into meaningful information by the Data Reduction Branch of the Armament Center.

IN a sense the evaluative test program is precision "kibitzing." Equipment undergoing test is operated over or along instrumented ranges and observed through a full cycle as closely as possible. Instrumentation equipment on the ranges used by the Center includes Contraves and Askania cinethodolites, radar systems, cameras, and other specialized equipment. Airborne equipment is widely used in the programs and may include magnetic recorders, cameras, and telemetry devices.

General Mechling is Commander of the Air Force Armament Center, Air Research and Development Command, with headquarters at Eglin Air Force Base, Fla.

Data gathered by the equipment are recorded on either photographic film, oscillogram tape, or magnetic tape. The photographic film may record changing electromechanical data dials of the test vehicle, while the oscillogram tape and magnetic tape are used to record changing amplitudes.

Correlation of data from multiple observation stations is necessary and is accomplished by recording a central time signal on the raw data record at the same time the test information is recorded. The geographical relationship between data-gathering stations is also of prime importance for correlating information and is known with first-order accuracy.

The complexity of the raw data records requires complex assessment and computation processes for reducing the information into usable forms. For this reason, personnel from the Data Reduction Branch of the Armament Center are affiliated with test programs from start to completion. When programs are established with the Program Control Office, project mathematicians are assigned to determine mathematical procedures and assessment and computation techniques to be used for proper data acquisition and reduction.

Because of the importance of the data reduction and processing techniques to the Armament Center's accomplishment of its mission, the Data Reduction Branch was evolved into a large and complex operation. Approximately $1,750,000 worth of electronic, mechanical, optical reduction, and computing equipment, plus the services of 80 persons, are now being used in this phase of the Center's program. The personnel staffing the Data Reduction Branch include representatives for the military, civil-service, and contracting groups.

THE most-used item in the inventory of computing equipment is the ERA 1103 Univac scientific computer. This digital computer is in use twenty hours a day with the other four hours being used for servicing and maintenance in order to keep it operating at optimal accuracy. It is this unit that furnishes the computations necessary in extremely precise measurement of armament characteristics.

When test missions are completed, raw data records are turned over to the Data Reduction Branch for processing. Four major steps are followed in trans-

lating the records into a form for analysis and presentation. These are preliminary evaluation, assessment, computation, and presentation.

The data records are first reviewed by a mathematician for coördination and to determine if all data-gathering equipment was functioning. In the preliminary evaluation phase of the data-reduction program the mathematician edits the data record to establish the areas to be assessed, the equipment to be used, and the type of output required for computation.

FOR example, photographic film, oscillographic tape, and magnetic tape may have been used on a particular mission with each operated at a different speed. The mathematician must determine at what time intervals the recorded information most nearly coincides.

The mathematician must also decide whether a Friden desk-type calculator will be sufficient for computations or will use of the Univac scientific computer or IBM 650 computer be required. He also must advise project officers as to the type of analysis or presentation which will give the greatest return.

A number of machines are available for each of the steps in the data-reduction program. In the preliminary evaluation phase the raw data may be displayed using either one or more of several machines. For oscillogram viewing there is a machine designed and built by AFAC personnel to facilitate handling, editing, and viewing. Two motor-driven spindles permit display of the data, and foot-operated controls allow variations in speed and reversal of the tape.

PHOTOGRAPHIC films may also be displayed on one or more of several machines. A trimetrogon film plotting table, made by the Compco Corporation, equipped with three film-transport systems draws the film across a translucent table top for editing and direct viewing of the film frames. This machine and a light table are used when magnification of the film is not necessary. Films used may include rolls in sizes from 35 mm. to 11 inches wide.

For magnification of 16-mm. and 35-mm. film a Recordak film reader, manufactured by Recordak Corporation, is provided. This reader is essentially a commercial microfilm reader. It provides magnification varying from 12 to 23 power. A Flofilm universal microfilm reader, manufactured by Diebold, Inc., is also provided for reading 35-mm. film.

Following the coördinating, editing, and preliminary evaluation of raw data records, accurate readings must be made as required. Generally these readings are made of amplitude changes, of test-vehicle position on film frames, and of data dial changes. Specialized equipment also is provided for this phase of the reduction program.

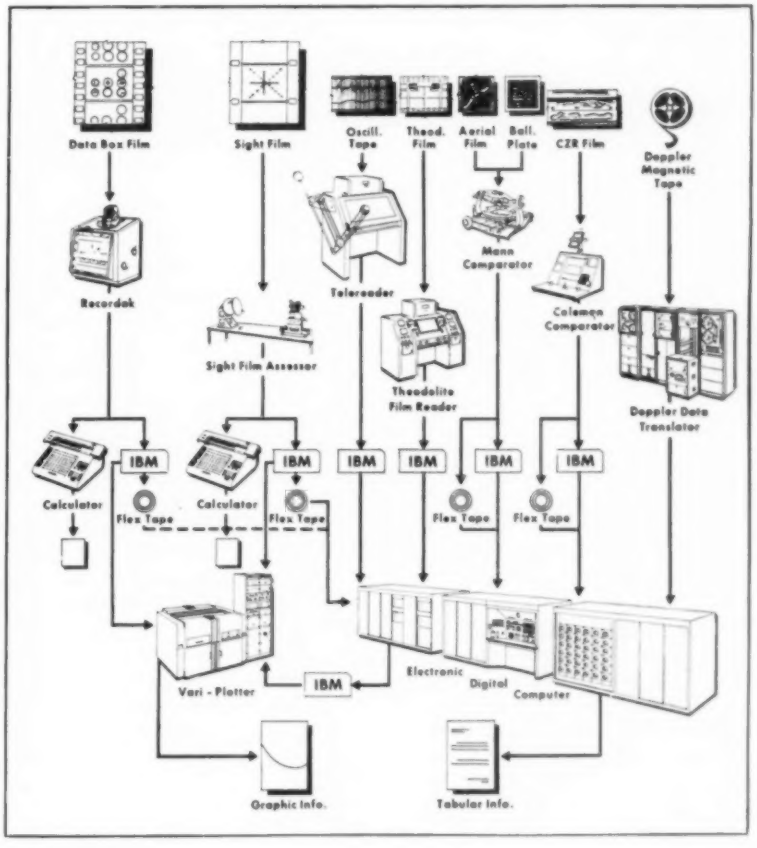
Most of the assessment equipment used by the Data Reduction Branch is semiautomatic in that punched cards, flex-tape, or tabulated outputs from a machine are used. These machines produce an output from the movement of reference marks from a zero or other position on the film. Provision is made for the operator to insert constant values from the machine consoles into the operation.

A Theodolite film reader, Model 4B-2, manufactured by Telecomputing Corporation, is used for reading Askania theodolite film. The operator uses a combination of manual settings, reticle scale readers, and a tracking error measuring device to arrive at elevation and azimuth angle determinations. Automatic readout information is provided by an IBM card punch and an electric typewriter.

THIS machine produces a standard deviation in reading errors for elevation angles of approximately 0.0003-degree. Azimuth angles can be read with the same accuracy except for nonlinear enlargement of errors due to multiplication of azimuth tracking errors by functions of the elevation angle.

Contraves cinethodolite film is accurately read on an Oerlikon film reader, Model 200-E. When film is evaluated, the image is projected on a 15- by 19-inch screen with a magnification of approximately 20 power. Azimuth scale, elevation scale, azimuth tracking error, and elevation tracking error may be read in degrees and decimal parts of

Data on armament performance is reduced to graphic and tabular form.



Armament Technology

a degree to three decimal places. These values and the frame count are displayed on the reader control panel.

AUTOMATIC readout of these values, with twelve digits of identification, may be obtained in the form of typewritten copy from electric typewriter and punched cards from an IBM summary punch. The Oerlikon reader has the facility for displaying correct frame sequences selected at intervals from one to ten frames.

Since the cross hairs in the Contraves theodolites appear to rotate on the film, it is necessary to have rotating cross hairs in the reader. After the reference cross hairs are aligned properly with the theodolite cross hairs, rotation is fully automatic, being accomplished when the elevation scale is read.

Provision for making *x* and *y* measurement of data on film is included in the Boscar Model A, manufactured by Benson Lehner Corporation. A film frame is projected greatly enlarged on a screen and a dot of light is positioned to lie on the point being measured. A joystick controls the dot of light and the *x* and *y* components of the joystick motion are converted into digital information.

Least counts as small as 1/1,600-inch may be set up separately for *x* and *y*. Constants are introduced in six dials. Automatic readout of information may be accomplished by cutting cards on an IBM key punch, punching paper tape, printing on a Flexowriter, or plotting on the Electroplotter.

Linear measurements in two mutually perpendicular directions are accomplished with a Universal Telereader, manufactured by Telecomputing Corporation. Unlike comparator-type machines, this reader can be zeroed almost instantly at any point, which allows reading directly from the original film. It does not record in absolute units but in telereader counts which can be calibrated readily.

Angles ranging from 0 to 360 degrees can be measured within a least count of one-tenth of a degree.

SCALE measurements from continuous trace records, 35 mm. to 12 inches wide, are possible with the Oscar and decimal converter, both manufactured by the Benson-Lehner Corporation. The Oscar has a 13- by 26-inch backlighted field of view with a hand-operated wind mechanism. A movable *x* time reference can be positioned at any point over about sixteen inches of the field of view. An amplitude measuring unit is mounted on a movable carriage. Either linear or nonlinear calibration traces may be mounted on the Oscar. This device furnishes a resistance output to the decimal converter or other translating plotters.

The decimal converter receives the resistance output and converts it into an electrical impulse which is used as an input to an automatic tabulator or an IBM keypunch machine. The converter will accept in sequential order one *x* and six *y* measurements from the Oscar.

A Coleman powered comparator, manufactured by Coleman Engineering Company, is a true comparator for reading film obtained during rocket or bomb tests. Two powered screws positioned at right angles to each other are turned to follow images on magnified film. The motion of the screws is converted into digital information which is registered on the face plate of the machine.

A keyboard of eight digits and six dials provides a method of introducing constants or time information. The information in the counters and dials may be read out on an IBM summary punch or a Flexowriter. A rotating table provides a means for making angular measurements.

THE equipment available to the Data Reduction Branch includes an attitude film reader which is an optical simulator to recreate the spatial relationship between an airborne camera and a ground target configuration. The attitude film reader allows recreation of the position of the aircraft carrying the camera to determine its attitude when approaching the ground target. The reader allows determination of the slant range, off-course angle, target angle, bank angle, and tracking error. Readout from this machine is visual.

Analog information may be digitized by the Vic-Dar data system equipment. The data recorder is capable of simultaneously digitizing and recording on magnetic tape up to twenty channels of analog information.

A Doppler data-processing system is used to process and convert to binary form analog data obtained from a Sperry velocimeter. The output of the Doppler data-processing equipment is introduced directly into the Univac scientific computer.

FM frequency variations recorded by special airborne recorders are analyzed by a Davies wave analyzer. The analyzer identifies frequency of modulation by beating a local oscillator against the magnetic tape output from the airborne recorders. Outputs of the analyzer are fed to a brush recorder which traces the voltage variations on a chart graph.

The Data Reduction Branch has a capability for doing large quantities of computations. It has a staff of desk-calculator operators with an adequate number of desk machines including Friden calculators and computypers; the Univac computer; access to two IBM 650 computers; and an Electrodata computer.

THE electronic computers used by the branch are all digital machines which do basic arithmetic operations under the control of an internally stored program. Once a program has been prepared and coded in the language of a particular machine, that machine can execute its instructions at electronic speeds.

The principal problem in using automatic computers is the preparation of the program and code. It is necessary to convert dial readings, shaft rotations, and voltages to digital information before they can be used in the computers. This is accomplished by punching IBM cards or paper tape or by special conversion methods.

The automatic computing facilities at the Data Reduction Branch are used for such problems as determining position and motion of aircraft from motion-picture records, computing theoretical bomb trajectories and drag functions, evaluating statistics of impact patterns, and editing digital magnetic recordings of test measurements.

The equipment and personnel of the Data Reduction Branch have capability for solving any foreseeable problem when data can be obtained from one or more sources. The place of the branch in the Air Force Armament Center program is of prime importance. Unless performance of developmental weapons and missiles can be measured quickly and accurately, progress will be mired in the prohibitively expensive wreckage of trial-and-error development.

Testing for Reliability

For guided missiles and other complex equipment, testing to failure normally will assure an order of component reliability several orders of magnitude higher than testing items merely to specified limits

Dr. Robert Lusser

This paper was presented at the Joint Military-Industry Reliability Symposium held recently at Redstone Arsenal, Huntsville, Ala., where Dr. Lusser is on the scientific staff.

TO compare the merits of testing to specified limits with those of testing to failure, we first have to visualize the level of component reliability we wish to achieve. Washing machines and home radios are simple and maintainable, therefore, a ninety-nine per cent level of component reliability might be acceptable.

Guided missiles, however, being very complex and not maintainable, require a component reliability several orders of magnitude higher. This is a severe challenge not only to the engineers, but to the test concepts as well.

Let us see what testing to limits and testing to failure can achieve. The upper section of the diagram on page 192 shows the principle of testing to specified limits.

THE test limit is indicated by the horizontal line. How precisely can this limit be determined? In most instances, the test limits are chosen arbitrarily. Naturally, if a component type is to be employed in a variety of equipments it is entirely impossible to determine a test limit that satisfies each of the different service conditions equally well. Let's take a radar component. The maximum shock may be 5g and may be caused by transportation. If the same component type were employed in a missile, the maximum shock may be as high as 100g. Now, what test limit shall we specify—5g, 100g, or what?

Let us now assume that somebody was courageous enough to specify a certain test limit. How many units must be tested to prove that a specified reliability has been attained relative to this limit? As a rule of thumb, we may say that the sample size must be one order of magnitude larger than indicated by the permissible reciprocate failure ratio.

For example, if we want to prove, with a confidence of ninety per cent, that not more than one unit out of ten thousand will fail—and this may be the minimum requirement for the components of complex guided missiles—we must test a hundred thousand units.

Such sample sizes are staggering. To make things worse, they must be repeated periodically in order to maintain design reliability in production. If we consider the hundreds, or perhaps thousands of component types employed in a guided missile, we realize that limit testing at such a huge scale is entirely beyond the possibility of human endeavor.

Testing to specified limits has other severe shortcomings. It leaves both the designer and the customer in complete darkness as to the ultimate strength and the characteristic variability of a component type. Absolutely nothing is learned about the safety factors and margins.

Worst of all, many critical modes of failure cannot be explored at all, because they don't show up at the specified test level. They may never be cured and thus constitute a permanent hazard to the missile.

NOW, let us see what testing to failure means and what it may accomplish. Whereas advocates of testing to limits fervently hope that *no* failures occur, advocates of testing to failure *produce* them intentionally because they want to study modes of failure at close range in order to find a quick and lasting cure.

Testing to failure has other advantages: Whereas in testing to limits we must test many thousands of units, in testing to failure we need to test only small samples, say twenty-five, ten, or even fewer units. Scattergrams of ultimate strength data thus obtained, although they defy accurate statistical evaluation, are of greatest significance to the engineer.

First, they tell him the strength or weakness of the individual units, and the degree of variation. He will relate the average strength to the maximum stress level, or "reliability boundary," to judge whether the safety factor or safety margin is large, moderate, or marginal.

Furthermore, he takes into consideration the characteristic variability of the test data and establishes a realistic index of reliability expressed by the num-

ber of standard deviations between average strength and the maximum stress.

SUCH scattergrams, safety factors, and safety margins provide the solid basis for down-to-earth discussions between designers, test engineers, manufacturers, vendors, and customers. Thus, the reliability situation of a component type may be cleared up quickly. Once all unknowns have disappeared, the component type may be redesigned and retested until an "absolute" degree of reliability has been reached.

In the lower part of our diagram, four characteristic reliability situations are shown. The strength scatterband of the component far left is narrow, but the average is so close to the reliability boundary that poor reliability is clearly indicated. The designer had better redesign it to raise the average strength.

The second component shows the same variability but a much higher average strength. Obviously this component is highly reliable.

The third component type shows a large average strength value relative to the reliability boundary, yet its variability is large too. The designer or test engineer must by all means determine the causes of variability and eliminate them until he can be sure that a high safety margin, expressed in the number of standard deviations between the average strength and the reliability boundary is attained.

The fourth component type in the diagram is so strong that the test data falls high above the reliability boundary, outside the diagram. Obviously, this component type may be considered "absolutely" reliable in that particular respect, and no further improvement is required.

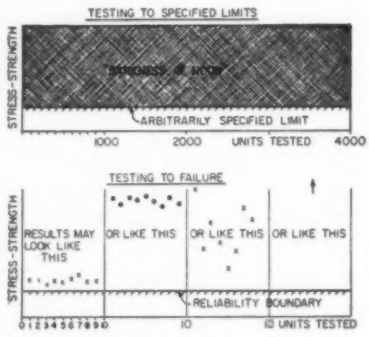
Systematic failure testing helps to clarify the reliability situation of a component type to such a degree that not more than one or two dozen units need be tested to increase its reliability by *orders of magnitude*. This is the real goal of reliability testing, not statistical accuracy.

LET us now return to the concept of testing to specified limits. It is difficult to understand why a test should be discontinued once a specified level of test severity has been reached. Shall, perhaps, the tested item be salvaged for use in a missile? This we should not tolerate because the tested item may have been made groggy by the test.

Thus, since the component must be discarded anyway, why not increase the severity of testing until the last secrets are squeezed out, like the juice of a lemon?

The concept of testing to limits need not be condemned entirely, however. In some instances, it might be useful. Pressure tanks, for example, must not leak under pressure. This may best be proved by pressure testing each and every tank up to a specified level.

Two factors are in favor of this pro-



Testing to limits vs. testing to failure.

cedure: First, pressure tanks are made of highly ductile material; secondly, the maximum service pressure may be stringently controlled and limited. Therefore one can safely test each tank up to the yield point without weakening it. A safety factor of more than 1.5 would still be available with regard to burst.

Of course, screening procedures like this must not be applied blindly. We must first determine the average yield pressure and its variability, then the average burst pressure and its variability. We must further determine the modes of failure, the safety factors, and the safety margins. In other words, *any test-to-limit program must be preceded by a thorough test-to-failure program.*

After production has been started, it must be repeated from time to time to prove that the inherent reliability has been maintained.

Electronic components may be tested to specified levels also. Take the example of insulation against voltage. If service voltage is 100 volts, and the breakdown voltage is known to be 1,000 volts with a small variability, we may test each production unit up to 300 or even 500 volts without any risk of damage.

Yet, as in the event of the pressure tank, *the screening process must be preceded by a thorough test-to-failure program.*

ALTHOUGH these arguments are almost a matter of course, testing to specified limits is still the vogue. Let me tentatively list some of the reasons for this procedure.

1. Many designers prefer testing to specified limits because they are not accustomed to considering variability as a prime cause of unreliability.

2. Manufacturers, in their effort to reduce cost, are often reluctant to conduct failure tests, because they may have to pay for them out of their own pockets, so guaranteeing specified limits appears more economical than determining ultimate strength values. This however, is a fallacy. In the long run they have to pay heavily for their negligence by losing their reputations and contracts.

3. Statisticians often prefer testing to limits because it requires no engineering judgment.

4. Sales managers, in general, feel that limit values are more easily understood, guaranteed, and advertised than ultimate-strength values.

5. Contracting agencies may feel that it is easier to specify and contract limit values than ultimate values. This is true, but this attitude is shortsighted in view of the serious reliability problem of complex automatic equipment.

6. Test engineers usually prefer routine testing to testing to specified limits because this requires less worry, effort, time, and company money than testing to failure. This again may be true, but how much does the failure of a missile cost the taxpayer in peacetime and how much in wartime?

7. Specification writers may prefer limit values which may be formulated without considering variability of stresses and strengths. True. But they don't know that it is just the inherent variability of a component type that kills expensive missiles.

8. Even customers may prefer limit values if they believe that components that comply with specifications are automatically "good" and reliable. This, of course, is a gruesome mistake.

A New Loading Process

The application of single-pour controlled cooling to filling bombs and other explosive ordnance has resulted in uniform high-quality rounds of better density together with greater simplification in the methods used

Brig. Gen. Joel G. Holmes

IT is a generally accepted fact that the three basic phases to all shell cast loading procedures are the melt, the pour, and the shell conditioning or cooling after the pour. In the application of Single-Pour Controlled Cooling (SPCC) to the first phase—the melt—the variables of dissolved or entrapped air, viscosity, and melt temperature are controlled by applying vacuum to the melt kettle during melting and by direct thermal control via appropriate sensing elements to an essentially enclosed system.

The second phase—pouring—likewise is standardized, in the case of Composition B and Cyclotol, by the use of appropriate jacketed downcomers and pouring heads and by the use of a votator for the generation of exact quantities of solid nuclei for multicrystalline growth when TNT is the casting material.

In the third phase, thermal control of the shell during cooling is effected by the application of a radiant heat source to the ogive and funnel of a shell while conveying the main body of the weapon through appropriate cooling media, thereby allowing full feed through the funnel throat until solidification below the booster region is essentially complete.

THE wide variety and types of shell that have been loaded in the SPCC pilot plant during the last year and a half have ranged in size from 75 mm. to 240 mm., amply demonstrating the flexibility of the process. In addition, the materials cast have included TNT, Composition B, and Cyclotol. It has also been found that aluminized and other multicomponet systems can be cast in this way, although no formal schedule for casting such rounds has been made.

General Holmes (U.S.A., Ret.) was a distinguished Ordnance officer in both World Wars. He is now serving as plant manager for the Iowa Ordnance Plant, Burlington, Iowa. This address was given at a recent meeting of the A.O.A. Loading Committee, Bomb and Artillery Ammunition Division, held at the Iowa Ordnance Plant.

The accompanying table summarizes the conditions used to cast the many types of conventional shell that have been scheduled for SPCC processing by the Ordnance Ammunition Command and Picatinny Arsenal. In number these range from less than 100 for some rounds to 15,000 for others, but in all cases the cycles were not considered developed completely until high-quality, cavity-free, uniform shell could be consistently cast with assurance —using a deep-cavity funnel at that.

In recent months a new application of the SPCC method of cast loading has been made to a weapon of less conventional design which, for security reasons, shall be designated simply as OAC Item No. 69. Without attempting to describe the make-up of this item in any detail, it can be said that it consists of three components; the first and smallest of which is loaded with approximately 4½ pounds of Composition B, the second with approximately 60 pounds of Composition B, and the final and largest section with approximately 100 pounds of Composition B.

The conventional method of loading the first of these is as follows: A bottom pour is made at 185 degrees Fahrenheit. Before this pour has crusted over, a clean funnel is inserted and a topping pour is made at 210 degrees Fahrenheit. More often than not this results in a cast with a large cavity encompassing the sides and bottom of the booster well. The defective area is then drilled out with a 2½-inch diameter drill and the cavity topped off with material at 205 degrees Fahrenheit.

THIS procedure yields an acceptable cast ninety per cent of the time. When it does not, it is necessary that the cast be redrilled and repoured. Because of the unreliability of the process, one hundred per cent X-ray is required of this and the other two sections to be described.

The conventional procedures for casting the intermediate and large-sized sections of Item No. 69 are both the same and consist of the following: A bottom pour is made with Composition B at 194 degrees Fahrenheit to approximately one inch of the top of the

funnel. In 2½ hours all the material from the funnel has fed into the cast below and an add pour at 196 degrees is made to within one inch of the top of the funnel.

This is allowed to cool for two hours, the funnel is removed, and its riser knocked out. The funnel is replaced, and other add pour at 196 degrees is made to within one inch of the top of the funnel. At the end of an hour and a half the funnel is once again removed and cleaned. The cast is processed with a cutdown tool, the funnel replaced, and a final 196-degree add pour made. The unit is then allowed to cool to room temperature.

DESPITE this almost custom-made method of manufacture, the quality of these casts is not always of the best. Densities above 1.660 are rarely achieved, and cavitation, even though within specification, is often present.

For these reasons and in order both to ensure a more uniform cast and to increase the reliability of process to the point where X-raying can be put on a sampling basis, the pouring of these rounds is being transferred to the pilot plant on a production scale. The application of the SPCC process to these items has already resulted in great processing simplification and has yielded high-quality rounds.

The processes developed in the order of size of the three components are as follows:

1. For the small charge, the radiant panel water is held at 320 degrees Fahrenheit and the circulating 120-degree coolant water level is maintained at 1½ inches from the throat of the round. The pour is made in this and subsequent cases at 190-degrees and, after a 4-hour cycle, the radiant panel is turned off. Once the funnel material has solidified, the casts are ready for final processing.

2. Acceptable intermediate-sized casts were obtained by the simple expedient of applying heat from the 320-degree radiant panel to the funnel region of the charge for 10 hours while simultaneously circulating 46-degree water in the bath directly below these units. The unseemly length of this cycle and that for the large-sized component, described below, is due to the fact that, unfortunately, because of the way in which the casings of these components are manufactured it is not practical to immerse them in circulating water.

3. The largest components are manufactured by keeping the radiant panel temperature at 290 degrees Fahrenheit during preheat, bringing it down to 275 degrees for 13 hours after the pour, and then holding it at 235 degrees for the last 4 hours before final freeze-up.

By these procedures uniform and high-density casts are obtained, but we would be remiss in accurate reporting if we did not point out several difficulties that were encountered.

THE first of these is concerned with the fact that the over-all final cast weights of these units are held within very close tolerances. These tolerances can be met to a certain extent by the addition and subtraction of separate weights. However, it was found in the case of the large units that when evacuated melts were cast, densities of the charges obtained were of the order of 1.70 grams per cubic centimeter, and that even with all extraneous weights removed, the over-all weight of the final component exceeded the allowable maximum. Only by regressing to unevacuated material (bringing densities down to the 1.68 grams per cubic centimeter range) was it possible to meet the weight requirement consistently.

Fortunately, this switch to unevacuated material has had no apparent deleterious effect on quality. It was also found that many of the shell cavities exceeded the desired volume by the equivalent of 2 to 2½ pounds of water, again making it impossible to stay within the maximum weight limits except with the lowest density casts.

Shell preheat and controlled cooling cycles established with current pilot plant equipment

Shell & Load	Shell Preheat*	Pouring Conditions		Controlled Cooling Conditions					Freeze-off Conditions	
	Water Level (In.)	*Melt Temp. °Fahrenheit*	*Oven Temp. °Fahrenheit*	*Bath Water Temp. °Fahrenheit*	*1st Water Level (In.)*	*Time (min.) at 1st Water Level*	*2nd Water Level (In.)*	*Time (min.) at 2nd Water Level*	*Cool Time (Min.)*	*Water Level (In.)*
75-mm. Cyclotol	....	202	320	...	...	30**	...	...	90	...
75-mm. Comp. B	12-1/2	185	320	120	6	60	...	...	60	6
90-mm. Cyclotol	...	202	320	120	7	60	...	...	60	7
90-mm. Comp. B	...	185	320	120	7	60	...	...	60	7
105-mm. Cyclotol	5	202	320	120	5	60	...	...	60	5
120-mm. Comp. B	6	190	320	120	6	240	...	...	60	6
155-mm. Comp. B	11	190	320	120	11	210	9	60	90	9
155-mm. TNT	10	176	320	80	10	270	...	...	90	10
8-inch TNT	13	176	320	80	13	330	8	120	90	8

**All rounds are preheated for 30 minutes prior to pouring.*
***W/O water on shell.*

The Steel Case Program

A review of the progress made in the development of steel cartridge cases for small-arms ammunition reveals that encouraging achievements have been made in many areas while some problems still await solution

Dr. Philip H. Burdett

THE Small Arms Steel Case Ammunition Committee of the American Ordnance Association was formed in 1949 as a Special Committee on Caliber .50 Steel-cased Ammunition. This followed the reactivation of the steel-case program at Frankford Arsenal with the assignment of establishing a pilot line to duplicate the process used at the Lowell Ordnance Plant during World War II.

Since that time work has been undertaken on steel cases for practically every military small-arms caliber including caliber .45, caliber .30 carbine, caliber .30, 7.62-mm. NATO, caliber .50, 20-mm. (M21 type), 20-mm. (M103 type), and 30-mm. A number of other facilities have been or are at present participants in this program.

It would be nice to be able to summarize the progress of the past seven years concisely and preferably in glowing terms. Progress there has been—real solid progress which most certainly strengthens our defense position. The advancements have not, however, been spectacular, nor have they generally been universally applicable to all our problems.

THE solutions to metallurgical and surface-finish problems frequently are uniquely applicable to one caliber or to ammunition for one type of gun, and the optimum solution to each situation must be sought individually.

There have been discouragements and frustrations, too. Sometimes these have been in the technical or equipment areas, but frequently they have resulted from changing military requirements which have prevented the responsible military agencies from giving individual programs the financial support necessary to wrap up the progress which has been made and to give assurance that an economical and technically sound process is available when needed.

Dr. Burdett is with Remington Arms Company, Bridgeport, Conn. As chairman of the A.O.A. Small Arms Steel Case Ammunition Committee, he gave the following address at a recent meeting of the Small Arms and Small Arms Ammunition Division held at Eglin Air Force Base, Fla.

Sometimes it has been necessary to set aside promising development work in favor of more expedient solutions to immediate problems. These experiences are, of course, not unique with this program, but they do lead to a certain uneasiness that promising leads may have been overlooked and that the solutions obtained to problems may not be the best in all cases.

In the early years of the program we had always before us a clear responsibility and a clear goal. Nowhere was serious disagreement found with the thesis that a military emergency would require large quantities of small-arms ammunition and that brass to manufacture this ammunition would be critically short. There was agreement that means could be found ultimately to produce satisfactory steel cases, and it was possible with a firm voice to recommend whatever steps were considered essential to the furtherance of this program.

RECENTLY, however, there have been some opinions voiced which, if accepted, would upset the clear simplicity of our goal. There have been those who, recalling the amounts of brass allocated to the ammunition program in World War II, feel that with the probability of all artillery cartridge cases being made from steel, in another emergency brass for small-arms ammunition would be in oversupply.

There have been others who, with particular respect to aircraft ammunition, believe that any future war will be a short war and will be fought with ammunition produced prior to mobilization. Since it will be possible to produce this ammunition from brass, they see no requirement for the development of steel cases.

Concurrently, we have heard elements of the Air Force express the opinion that, with modern high-cyclic-rate guns, only steel, of the candidate metals, can be counted on to produce adequately strong cartridge cases. At the same time we hear other responsible defense officials stating that in

times of emergency all materials will be critical, only some will be relatively less unavailable than others. It is estimated that seventy per cent of the raw material for brass is imported.

Specifically, the Assistant Secretary of Defense for Engineering has issued strongly worded warnings concerning the necessity for conservation of materials and has cited the use of steel for cartridge cases as an example of what has been and can be done.

IN the face of such conflicting attitudes, there was real concern lest the steel-case program for small-arms ammunition be shelved to make way for other projects for which a more dramatic and universally accepted need existed. In June 1956 the American Ordnance Association urged continued support of the small-arms steel-case program—proposing specifically the manufacture of noncombat small-arms cartridge cases from steel within the limits of available know-how. This would include practice rounds, dummy cartridges, blank cartridges, and perhaps other miscellaneous items.

It was explained that the program had reached the place where further progress required extensive production experience to determine the process reproducibility under production conditions, to give the steel suppliers an opportunity to determine the feasibility of furnishing the desired grades of steel, and to give the using services the experience and confidence required before standardization would be considered.

A REPLY was received from the Assistant Secretary of Defense for Engineering, from which the following is an excerpt:

"The Army acknowledges the need for the development of suitable designs and production processes for small-arms steel cartridge cases and anticipates the development of designs and processes that will permit the unrestricted use of steel-cased small-arms ammunition. However, in consideration of such factors as existing designs, military requirements, mobilization requirements, stock position, and weapon obsolescence, efforts at the present time in those areas where the Army has responsibility are being limited to the caliber .30, caliber 7.62-mm., and Air Force 20-mm. (60/20) rounds. The decision to concentrate effort on these rounds appears proper. The Army plans are consistent with the policy of this office to encourage development during peacetime of designs and processes which result in the conservation of critical materials.

"Dealing more specifically with your proposal for immediate use of steel cases in the training rôle, the Army is now taking steps to standardize the caliber .30 round with a steel cartridge case for training use and plans annual procurement of these at a rate consistent with requirements and facility capabilities.

"With respect to the 60/20 round, Army procures ammunition not for its own but for the Department of the Air Force use. Personnel of the latter department have indicated their plans for early standardization for procurement of the training round with a steel cartridge case. . ."

THE caliber .30 program referred to in this reply is being carried out on a limited scale. The 7.62-mm. program has been held up pending weapon standardization, and the 60/20 program has been implemented to a limited degree, although the hoped-for standardization of a training round by the Air Force has not yet been accomplished.

A detailed discussion of the technical problems which have arisen would be out of place here, but three major problem areas deserve mention.

Steel.—Throughout the postwar program all participants have been plagued by the necessity of procuring steel in small quantities which would not generally justify the steel companies' producing special heats for the purpose. It has usually been necessary, therefore, to use material which was available, even though it was not considered optimum for this purpose.

"Progress on steel cases during the past seven years has been slow and sometimes painful. However, some work has been performed with each of the military small-arms calibers, and in no instance does there appear to be any real obstacle to the manufacture of a satisfactory steel case. What is needed most is additional experience. This applies not only to facilities which manufacture the cases but to the steel companies which must supply basic material."

In spite of this, considerable progress has been made. It was originally felt necessary to specify spheroidized, cold-finished stock to take advantage of the relatively clean surface and close thickness tolerance associated with cold-finishing. Later, hot-finished material was used, grinding the disks to clean up the surface and obtain the necessary thickness tolerance.

More recently some facilities have had a considerable amount of success in using hot-rolled material without grinding. With at least one process under consideration, it is hoped that spheroidization ultimately will not be required.

Heat Treatment.—On the basis of World War II experience, it was agreed that initially reliance should be placed on a fully heat treated case. Although it had frequently been possible to produce cold-worked cases which performed satisfactorily, occasional failures occurred which it was felt would not have been experienced with fully heat treated cases. The development of satisfactory production-type equipment for the oriented heat treat and quench required by the larger cases has not yet been successfully accomplished.

Recently, experimental work has been undertaken on a novel-type furnace in which the cases are not oriented and on a process for heat treatment which could be performed on relatively inexpensive, simple equipment.

One radically different process, employing no quench hardening and a novel method of producing a ductile flange, has shown very great promise. However, budgetary restrictions and the lack of Air Force requirements for the 20-mm. M21-type steel case have forced the Ordnance Corps to dismantle this pilot line. This is viewed as being a most serious loss, since it represented the only unique approach to the problem.

Surface Finishes.—In the early 1940's the limitations and inadequacies of the chromated zinc surfaces for steel

cartridge cases were recognized, but in the postwar program, for lack of an approved alternate, practically all facilities have been forced to install capacity for this type of finish. Recently, however, the use of epoxy-modified phenolic varnishes has been approved for caliber .50 and the 20-mm. (M21 and M103 types). This general type of finish has been used successfully on artillery steel cases for years.

It is believed that this represents a real step forward, and, although a number of problems remain to be resolved, it is believed that the extension of the use of these organic finishes in the larger small-arms calibers can be anticipated. Their applicability to the small calibers, where individual racking is impractical, is still questionable, since no method of bulk application has yet been devised.

"There are those who, recalling the amounts of brass allocated to the ammunition program in World War II, feel that with artillery cartridge cases being made from steel, in another emergency brass for small-arms ammunition would be in oversupply. There are others who, with particular respect to aircraft ammunition, believe that any future war will be a short war and will be fought with ammunition produced prior to mobilization. Since it will be possible to produce this ammunition from brass, they see no requirement for the development of steel cases."

A QUICK rundown of the status of various calibers may be of interest:

Caliber .45.—The caliber .45 cartridge case has been standardized on a cold-worked steel case. It uses a barrel-plated, chromated zinc surface.

Caliber .30 Carbine.—A process for making this case is available, but adequate stocks are on hand, and it appears that the round is being phased out of the Army program. Should it be revived, there are certain questions concerning the methods of pressure test and numerical values of pressure and velocity to be adopted.

Caliber .30 and 7.62-mm. NATO.—These two are grouped together because it is the hope of Ordnance to have interchangeable lines capable of producing whichever type of cartridge is required. They are considered particularly important, since an estimated twenty-five per cent of all small-arms and artillery cartridge-case metal will go into these two calibers.

Production experience on the caliber .30 round has been quite encouraging, using an unoriented heat treat and a barrel-plated, chromated zinc surface.

The 7.62-mm. NATO round has been standardized with a brass case and has not been produced in steel in production quantities because production has been held up awaiting weapon standardization. However, experimental work has been encouraging and supports the hope of Ordnance that interchangeable caliber .30-7.62-mm. lines can be established. With the standardization of the M60 machine gun and the M14 and M15 rifles it is to be hoped that additional production of this item can be supported.

Caliber .50.—The caliber .50 case is currently made using an oriented heat treatment. The standard finish is chromated zinc, rack-plated, and epoxy-modified phenolic varnish has been approved as an alternate finish. The Continental Army Command has recommended standardization of the steel-case round for use in temperate climates. It is anticipated that Alaskan tests now nearing completion will permit standardization for worldwide use.

20-mm.-M21 Type.—This type of round has been produced successfully by a process involving only cold work. Complete success has not yet been achieved in the heat-treated case. Both chromated zinc and phenolic varnish are authorized as surface finishes. This round is now being phased out of the Army program by introduction of the M39 and T171 guns.

20-mm.-M103 Type (60/20).—Comparisons between the success of brass and steel in this round are difficult because of the variety of gun models in which it is employed. In general, however, it is believed that the steel case has been equal to or superior to the brass case. In particular, the brass case appears marginal with respect to case strength, as evidenced by a high percentage of stretched cases which could lead to case separation. The steel case has not given this trouble.

In addition to the conservation of brass and the provision of a stronger case, the use of steel appears to have two other potential advantages. In this caliber there is an indicated saving of twenty pounds in weight per thousand rounds. There is, in addition, a cost saving.

T171 guns as presently manufactured are considered satisfactory for use with steel cases. This is also true of M39 guns manufactured after March 1957. However, existing M39 guns must be modified for satisfactory performance, and these modifications, however desirable, are not absolutely required if brass-cased ammunition is to be used.

THE retrofit of all existing guns would be expensive enough to cause some hesitancy about making the change. This cost, however, is only about twenty-five per cent of the savings which could be realized if steel-cased ammunition were adopted for target practice rounds for the next two years.

There are large mobilization requirements for this round, but the standardization by the Air Force for practice use, anticipated in the Secretary's letter quoted above, has not yet occurred. Facilities for the manufacture of this steel round, therefore, comprise a small pilot line in one plant, one production line in another, and one production line now being coverted to steel.

The Army has a new development program for a system employing a similar case, for which steel is specified.

Progress on steel cases during the past seven years has been slow and sometimes painful. However, some work has been performed with each of the military small-arms calibers, and in no instance does there appear to be any real obstacle to the manufacture of a satisfactory steel case. What is needed most is experience. This applies not only to facilities which manufacture the cases but also to the companies which must supply the steel.

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JULY-AUGUST 1957

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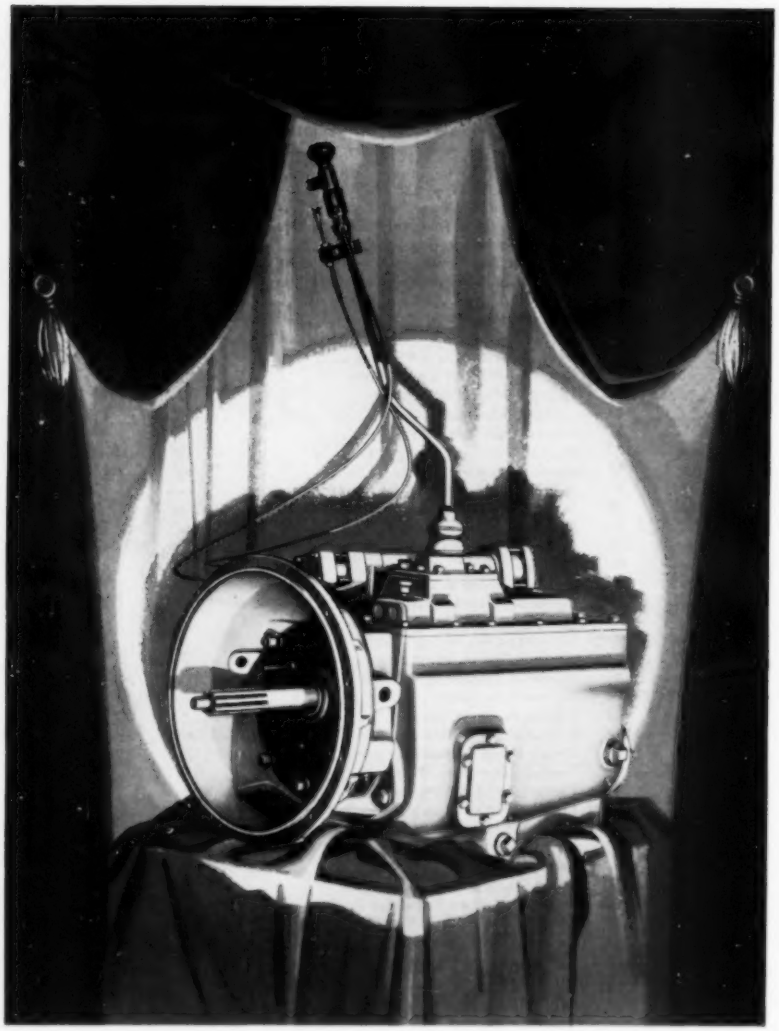

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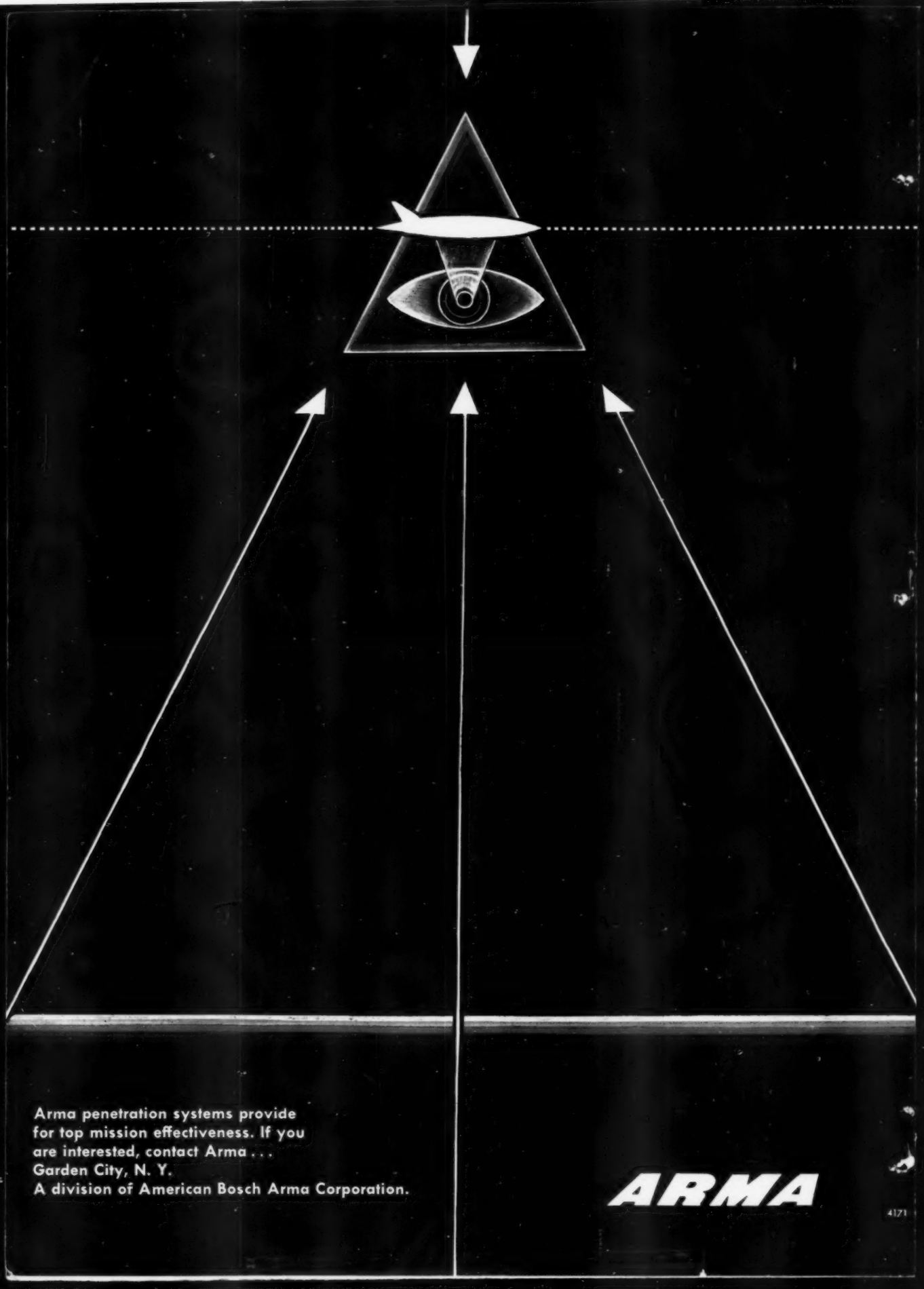

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